# *Proceedings of*

# ENTOMOLOGICAL SOCIETY of BRITISH COLUMBIA

**Volume 51** **Issued November 30, 1954**

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# OBSERVATIONS ON A BLACK FLY PEST OF CATTLE IN BRITISH COLUMBIA (DIPTERA: SIMULIIDÆ)*

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In Canada, particularly in the northern forested area, black flies are commonly regarded as a pest of man. However, there have been some notable outbreaks in Saskatchewan in which cattle were attacked with heavy losses. Cameron (1918, 1922) reported the loss of 100 head at Duck Lake in 1913, and indefinite losses at other times. Millar and Rempel (1944) described an outbreak at Macdowell, in which the loss was estimated at 132 animals valued at $20,000. Further outbreaks in 1945 and 1946 were dealt with by Rempel and Arnason (1947). All these attacks are attributed to *Simulium arcticum* Mall., but elsewhere large-scale attacks have been made by other species. Matheson (1950) summarized records of infestations affecting domestic and wild animals in the Danube Valley, and a wide range of domestic animals in the lower Mississippi region. Lohmann (1943) described injuries to cattle by black flies in Germany. This paper deals with an infestation of black flies in the Cherryville district of British Columbia in the years 1950–52.

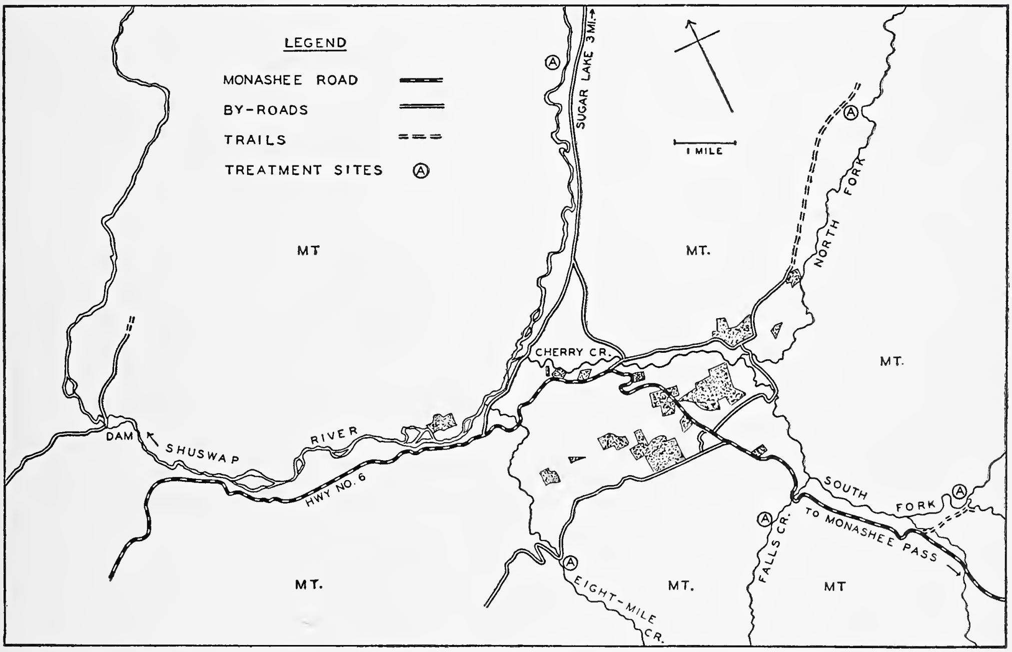


Fig. 1. Map of Cherryville (B.C.) district, prepared from aerial photographs. Stippled areas indicate clearings of home ranches.

## The Problem

The Cherryville district (Fig. 1) lies in a valley on the western approach to the Monashee Pass in the Monashee Mountains, and is isolated from large centres of population and from other farming districts. The settled area is about 8 miles long and 3 miles wide, and is traversed by the Shuswap River and Cherry Creek.

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The part of the Shuswap involved in the present study originates in Sugar Lake, which it leaves through a storage dam maintained by the British Columbia Power Commission. It flows in a generally southerly direction for a few miles, swings west and north to a power dam at Shuswap Falls, then runs northerly to Mabel Lake through a sparsely settled valley. From Sugar Lake to the power dam is about 12½ miles. The flow in this stretch is regulated at the storage dam and varies from 700 to 3,000 cusecs according to power requirements. Throughout this part of its course, the river is wide and shallow, with a bottom composed of boulders and gravel.

Cherry Creek enters the river about midway between the two dams, and varies in its flow from 45 to about 400 cusecs. In its upper reaches the creek has two main streams — North Fork and South Fork — as well as a number of smaller tributaries, all of which rise in heavily timbered mountain valleys and flow rapidly down to the river. The water of these streams is relatively clear, but since the distances to be covered are not great, the lack of turbidity is not a barrier to effective treatment with DDT (Fredeen *et al.* 1953).

Most of the residents of this district are engaged in logging, but there are several small beef-cattle ranches. Since the available range is confined to the bush on the lower slopes of the surrounding mountains, the number of animals that can be maintained is limited, and the more progressive farmers have in recent years begun to specialize in raising pedigreed stock. Their animals are marketed at various bull sales and fat-stock shows, and prime condition is essential if good prices are to be obtained.

The black fly situation first became known to the staff at Kamloops in the late summer of 1951, when farmers complained that their animals were being attacked by an unknown fly that caused them to leave their wooded pastures for the open roadsides. The flies attacked the eyelids and the soft underparts, particularly the udders, so that the cows would not tolerate their sucking calves. The ranchers first became aware of this when the normally white-faced calves appeared with faces reddened with their mothers' blood. When questioned, most residents declared that the fly had been unknown until a few years previously, when it appeared in small numbers, later building up to pest proportions; a few even blamed its introduction upon passing migrant farmers and their outfits from the drought-stricken areas of the Prairies in the mid-thirties. However, some natives of the district stated that they had known the fly all their lives. It seems probable that the species is indigenous to the area, but that in earlier times, when ranchers turned out their stock in the spring and did not see them again until fall, they were unaware of the pest and its effect upon their animals. Later, when registered stock were introduced and their condition became a matter of dollars and cents, they were watched more closely and the ravages of the fly became known. There are no records of humans being bitten by this fly.

Although the area affected is small, the losses in weight of cattle attributable to this pest were considerable, and bore upon individual ranchers to such a degree that some doubted their ability to stay in business unless relief was obtained. In 1952 the local cattlemen's association (E. A. Rannie, *in litt.*) calculated a loss of $24,160 on beef animals alone, in addition to losses on bulls, the prices of which largely depend upon the results of judging in the show ring.

Adult flies taken from the cattle in 1951 were submitted to the Systematic Entomology Unit, Entomology Division, Ottawa, for determination; Mr. G. E. Shewell reported that, although the flies closely resembled *Simulium arcticum* Mall., they were of an apparently undescribed species.

In the spring of 1952 I examined the smaller creeks in the Cherryville district and found no evidence of breeding. High water in the Shuswap River and Cherry Creek prevented thorough examination of these streams until mid-July, when both yielded pupæ that keyed out to *S. arcticum.* Adults reared from these pupæ were the same as those previously submitted to Ottawa. It is interesting to note that Hearle (1932) reported *S. arcticum* from several localities in British Columbia, including the Okanagan Valley, and Malloch (1914) gave Kaslo, British Columbia, as the type locality for this species. Mr. Shewell (*in litt.*) stated that he examined Hearle's British Columbia specimens and found them to be of *S. arcticum,* but a series taken by Hearle at Ione, Washington, and labelled *S. arcticum* conformed to the Cherryville species.

During 1952 Dr. W. R. Gunn, Provincial Live Stock Commissioner, requested the Provincial Entomologist, Mr. C. L. Neilson, to assist toward the achievement of control of the pest, and agreed to provide necessary materials.

## Control

During the winter and spring of 1952–53 frequent visits were made to the area, and on March 1 a few early-instar larvæ were found in the Shuswap River, which then had a temperature of 38° F. None was found in Cherry Creek, which was 2 degrees colder. On March 17 the river was heavily infested, and the creek, which had risen in temperature to 39° F., had a few scattered larvæ in its lower reaches. By April 16 a few pupæ had appeared in the river, and DDT larvicide was applied without delay. Twenty-five per cent emulsifiable concentrate at one part of DDT in 10,000,000 for fifteen minutes (Hocking, Twinn, and McDuffie, 1949) was applied at a point 5½ miles above the mouth of Cherry Creek. In Cherry Creek the larvæ, with few exceptions, were still in the earlier instars. By May 1, pupæ were beginning to appear in the smaller creeks, and DDT at the same dosage was applied to both forks of Cherry Creek, Falls Creek, and Eight Mile Creek, at points indicated on the map (Fig. 1). These treatments removed practically all larvæ in the creeks, and in the river as far as the power dam at Shuswap Falls.

On June 26 Cherry Creek and the river below its mouth had become heavily reinfested, and the treatment of these waters was repeated. However, by this time the streams were in full freshet, and much larger quantities of larvicide were required than in the spring treatment. Two weeks later large numbers of larvæ were found in Eight Mile Creek, but these were quickly cleared out with DDT, and no more appeared in any waters of the district.

The results of the treatments appeared to be satisfactory. Whereas formerly the cattle were congregated in the day-time along roads and barns, and specimens of the black fly were easily taken from them, they were now scattered through the bush and, in the manner of range animals, unapproachable. Diligent sweeping of the foliage in suitable places produced no black flies. Ranchers interviewed stated that, although they had occasionally seen small numbers of flies on their animals, they were far below the pest level, and they were more than satisfied with the degree of control obtained.

## Life-history and Habits

Little is yet known of the life-history of this fly. It overwinters in the egg stage, and hatching has taken place in waters having a temperature of 38° F. The reinfestation after the first treatment indicates that hatching continues over an extended period. Emergence of the adult flies, in the first two years of observation, was completed by mid-July, and the flies are reported by residents to be found from then until the first frosts. In contrast to the Saskatchewan outbreaks, which may occur as far as 100 miles from the breeding-sites (Rempel and Arnason, 1947), the species here discussed has not been reported more than 5 miles from streams in which it breeds.

This may be due to the mountainous and heavily timbered nature of the terrain. As a result of the work done in 1952, it was thought that this species, like *S. arcticum,* confines its breeding to comparatively large streams, However, the infestation of Eight Mile Creek, the maximum flow of which is 20 cusecs, implicates the smaller streams, and suggests that the upper reaches of the larger ones must be treated for satisfactory control.

## Acknowledgments

The writer appreciates the assistance of the following: Mr. E. A. Rannie, Secretary, Cherryville and District Cattlemen's Association, for liaison with the ranchers; Mr. C. L. Neilson, Provincial Entomologist, for assistance in the field; Mr. J. Stewart, British Columbia Power Commission, Vernon, B.C., for providing data on the rate of flow of the Shuswap River; and the Provincial Department of Agriculture, which underwrote the cost of control measures.

## Summary

A cattle-infesting black fly, closely related to *S. arcticum* Mall., caused serious loss of weight in beef animals in the Cherryville district of British Columbia. It overwinters in the egg stage; the first larvæ appear about March 1 and the pupæ in mid-April; adult emergence is complete by mid-July. Adults are on the wing for the remainder of the summer. A satisfactory degree of control was obtained with DDT, 25 per cent emulsifiable concentrate, applied at one part of DDT in 10,000,000 for fifteen minutes in near-by streams.

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## NOTE

*Ilybius inversus* Shp. (*Coleoptera: Dytiscidæ*). Just too late to get into Hatch's "Adephaga," I took four specimens of the above species in a small lake at Barkerville, B.C. (4400 feet). The species is almost unknown in collections and was described by Sharp in 1882 from a specimen labelled merely "N.A." The insects are the size of our larger *quadrimaculatus,* strongly convex, somewhat pallid, and distinctly bronzed. Mr. J. B. Wallis verified two of the specimens.—*G. Stace Smith.*

# CHEMICAL CONTROL OF THE PEAR LEAF BLISTER MITE, *ERIOPHYES PYRI* (PGST.), IN BRITISH COLUMBIA*

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In British Columbia the pear leaf blister mite, *Eriophyes pyri* (Pgst.), was first recorded from Agassiz in 1894 (Venables 1937). This mite is capable of causing severe damage to the fruit and foliage of pear, and to some varieties of apple, especially Newtown and Rome Beauty. The damage appears on foliage as blisters, as implied by the name of the mite. If the infestation is severe, early defoliation, and extensive russeting and cracking of the fruit may occur.

Although it may be satisfactorily controlled with a dormant application of lime-sulphur, information was needed on the susceptibility of the mite to acaricides applied at the pink bud stage. C. V. G. Morgan, of the Summerland laboratory, has shown (unpublished data) that the European red mite, *Metatetranychus ulmi* (Koch), may be more efficiently controlled at the pink bud stage than at the dormant stage. If the " pink " spray were adequate against the blister mite, it would have the advantage of simultaneously controlling both species of mites. However, at the pink bud stage most of the blister mites are present inside newly formed blisters on the young leaves. To be effective against them, a spray would have to penetrate the blister or the healthy leaf tissue. This is a report on the effectiveness of a systemic insecticide, the organic phosphate Systox (diethyl ethyl mercaptoethyl thiophosphate) and malathion applied at the pink bud stage and of common dormant sprays.

## Methods

Four blocks of Newtown apple-trees, with a fairly uniform infestation of the blister mite, were selected for the experiment. Two blocks were sprayed with a Turbo-mist automatic concentrate sprayer and two with a high-volume hand-gun machine. Each orchard block was divided into eight plots; five were treated in March, during the dormant stage, and two in April, at the pink bud stage, one plot being left as a control. Records of leaf infestation were made in late summer by randomized sampling of 100 leaves from each of ten branches per tree, three trees being sampled in each plot of the four blocks. The materials, their amounts, and the stages at which they were applied are given in Tables I and II.

## Results and Discussion

Results from the two hand-sprayed orchards are summarized in Table I and those for the two concentrate-sprayed orchards in Table II. The tables show that neither malathion nor Systox was effective against the blister mite at the pink bud stage, whether applied with a hand-gun or with a concentrate sprayer. In a previous experiment, 15 per cent parathion at 7.5 pounds plus lime-sulphur at 6.5 gallons per acre, applied as a pink bud spray, gave similarly poor control.

Dormant oil alone evidently gave little control of the blister mite. This is not in agreement with several authors (Quaintance 1916, Hawley 1926, Childs 1924). Childs stated that dormant oil is effective against the blister mite and that, since it kills by contact action, it must penetrate beneath the bud scales. Consequently, it is most effective when its viscosity is reduced by warm weather. Childs used an oil of 100–110 S.S.U. Vis. at 100° F., whereas in this experiment the oil was of 200–220 S.S.U. Vis. at 100° F. Perhaps the difference in oil viscosity was, at least in part, responsible for the difference in control. Childs

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**Table I.—Percentages of Leaves Blistered by the Pear Leaf Blister Mite in Two Orchard Blocks in Which Various Acaricides Were Applied with a Hand-gun Sprayer at Two Stages**

| Stage | Acaricide | Amount per 100 Gal. | Amount per Acre | Percentage of Leaves Blistered | | |
|---|---|---|---|---|---|---|
| | | | | Block 1 | Block 2 | Average |
| Dormant | Lime-sulphur[1] | 10 gal. | 50 gal. | 5 | 3 | 4 |
| Dormant | Dormant oil[2] | 2 gal. | 10 gal. | 9 | 2 | 6 |
| | DNOC (40%)[3] | 1.5 lb. | 7.5 lb. | | | |
| Dormant | Dormant oil | 2 gal. | 10 gal. | 8 | 4 | 6 |
| | Lime-sulphur | 4 gal. | 20 gal. | | | |
| Dormant | Lime-sulphur | 4 gal. | 20 gal. | 9 | 6 | 8 |
| Dormant | Dormant oil | 2 gal. | 10 gal. | 25 | 30 | 28 |
| Pink bud | Malathion (25%)[4] | 2 lb. | 14 lb. | 44 | 32 | 38 |
| Pink bud | Systox (42.4%)[5] | 0.25 pt. | 1 qt. | 46 | 42 | 44 |
| | Check, no treatment | -------- | -------- | 35 | 51 | 43 |

[1] Specific gravity 1.28. Oliver Chemical Company, Penticton, B.C.
[2] Viscosity 100° F., 200–220 S.S.U.; Shell Helix 29. Shell Oil Company, Penticton, B.C. Emulsified with soya-flour, 0.5 pound per 100 gallons.
[3] DN Dry Mix No. 2. Dow Chemical Company, Midland, Mich.
[4] Wettable powder. American Cyanamid Company, New York, N.Y.
[5] Diethyl ethyl mercaptoethyl thiophosphate; emulsifiable liquid. Geary Chemical Corporation, New York, N.Y.

**Table II.—Percentages of Leaves Blistered by the Pear Leaf Blister Mite in Two Orchard Blocks in Which Various Acaricides (as in Table I) Were Applied with a Concentrate Sprayer at Two Stages.**

| Stage | Acaricide | Amount per Acre | Percentage of Leaves Blistered | | |
|---|---|---|---|---|---|
| | | | Block 3 | Block 4 | Average |
| Dormant | Lime-sulphur | 20 gal. | 7 | 16 | 12 |
| Dormant | Dormant oil | 6 gal. | 5 | 17 | 11 |
| | DNOC (40%) | 4 lb. | | | |
| Dormant | Dormant oil | 3.8 gal. | 19 | 22 | 20 |
| | Lime-sulphur | 7.7 gal. | | | |
| Dormant | Lime-sulphur | 9.2 gal. | 12 | 20 | 16 |
| Dormant | Dormant oil | 6 gal. | 21 | 32 | 26 |
| Pink bud | Malathion (25%) | 12 lb. | 56 | 48 | 52 |
| Pink bud | Systox (42.4%) | 1 qt. | 51 | 31 | 41 |
| | Check, no treatment | -------- | 62 | 35 | 48 |

added that oil gives best results just after the buds have begun to burst. Presumably it is then able to penetrate more readily to the hidden mites. In the present experiment the oil was applied before the buds had started to open, and it may have been used too early for maximum effectiveness.

The other dormant spray mixtures, dormant oil-DNOC (4,6-dinitro ortho cresol), dormant oil-lime-sulphur, and the two concentrations of lime-sulphur, gave good control of the blister mite. High-volume hand-gun application was more effective than concentrate spraying, but the two methods are not comparable in that the high-volume method involved considerably more toxicant per acre. The dormant oil-DNOC mixture controlled the blister mite as well as the high dosage of lime-sulphur. This is useful information because the mixture is cheaper, is not so unpleasant to handle, and is useful against a greater number of orchard pests than lime-sulphur.

## Summary

In high-volume spraying, the following dormant spray mixtures gave good control of the blister mite and were approximately equal in effectiveness: Dormant oil-dinitrocresol, lime-sulphur, and dormant oil-lime-sulphur. Dormant oil, 2 per cent, had little effect. A pink bud spray of the systemic insecticide Systox or of malathion had no effect on the blister mite. The control was not so good where the mixtures were applied with a concentrate sprayer as with a hand-gun sprayer, perhaps because lower amounts of spray materials per acre were applied in the former.

## Acknowledgments

Thanks are due to Messrs. F. Seemungal, G. F. Lewis, and G. D. Halvorson, of the Summerland laboratory, for their assistance, and to Mr. C. V. G. Morgan for permission to refer to unpublished data.

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## EX-PLANT QUARANTINE CHIEF DIES

A man who guarded B.C. crops against transported diseases for more than a quarter of a century has died in Kelowna.

Funeral of William Henry Lyne, former Chief of Plant Quarantine with the Department of Agriculture, was held from St. Michael and All Angels' Church, Kelowna, Archdeacon D. S. Catchpole officiating.

Mr. Lyne, who was born in Oxfordshire, England, came to Canada in 1890 and fifteen years later settled in Vancouver. He immediately joined the Department of Agriculture and then became plant quarantine chief until his retirement in 1933. A charter member of the Interstate Plant Quarantine Board, which held its first meeting at Riverside, Calif., in 1919, Mr. Lyne also was a member of British Columbia Entomological Society.

He is survived by his wife, residing in Kelowna; two daughters, Mrs. P. G. James, Kelowna, and Mrs. Donovan Allen, Vancouver; a sister, Mrs. E. Cleveland, New Westminster; a brother, J. H. Lyne, New Westminster; five grandchildren and one great-grandchild.—*Vancouver Province.*

# STRAINS OF THE EUROPEAN RED MITE, *METATETRANYCHUS ULMI* (KOCH), RESISTANT TO PARATHION AND MALATHION IN BRITISH COLUMBIA.*

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In 1948 rose-growers in Connecticut and New Jersey encountered in their greenhouses a strain of the two-spotted spider mite, *Tetranychus bimaculatus* Harvey, that had become immune or resistant to parathion in an aerosol form (Smith and Fulton 1951). Since then there have been reports of orchard mites becoming resistant to parathion in the Pacific Northwest. O'Neil and Hantsbarger (1951) found a strain of the European red mite, *Metatetranychus ulmi* (Koch), in an orchard in the Wenatchee Valley, Washington, resistant to parathion. Newcomer and Dean (1952) reported the presence of strains of two species of mites resistant to parathion in the Yakima Valley, Washington, in 1951.

The first indication of parathion-resistant mites in the Okanagan Valley of British Columbia was noted in 1953. A grower in the Oliver district could not control an infestation of the European red mite with three sprays of 15 per cent parathion wettable powder, the first two sprays being applied at the recommended rate of 8 pounds per acre and the third at 12 pounds per acre. Numerous mites of all stages were found on the foliage four days after the last application. During the four previous years, this grower had applied, by hand-gun machine, an average of two sprays of parathion per year at 1 pound per 100 gallons per spray and had obtained satisfactory control. An experiment was conducted in this orchard to compare four non-phosphate acaricides with parathion and malathion. Ovotran, Aramite, and Sulphenone controlled the mites satisfactorily; DNOCHP gave good control for two weeks, but the mite population started increasing three weeks after the application (Table I). A week after the application it was evident that the control given by parathion or malathion was not adequate, although those two materials normally kill the mites very rapidly. The two plots were sprayed immediately again, DNOCHP being applied to the parathion plot and Aramite to the malathion plot.

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**Table I.—Average Numbers of the European Red Mite per Leaf[1] before and after Applying Acaricides by Concentrate Sprayer in July, 1953**

| Acaricide | Amount per Acre | Before Spraying | After Spraying | | |
|---|---|---|---|---|---|
| | | | 1 Week | 2 Weeks | 3 Weeks |
| Ovotran, 50%[2] | 8 lb. | 17 | 4 | 1 | 0 |
| Aramite, 15%[3] | 12 lb. | 19 | 3 | 1 | 0 |
| Sulphenone, 50%[4] | 20 lb. | 39 | 9 | 3 | 1 |
| DNOCHP, 40%[5] | 2 lb. | 23 | 3 | 1 | 3 |
| Malathion, 55%[6] | 5 pt. | 48 | 19 | Sprayed | |
| Parathion, 15%[7] | 8 lb. | 27 | 23 | Sprayed | |
| Check, no treatment | -------- | 13 | 8 | 10 | 7 |

1 Based on twenty-five leaves from each of four trees.
2 Para-chlorophenyl p-chlorobenzenesulphonate; wettable powder. Dow Chemical Company, Midland, Mich.
3 Beta-chloroethyl-beta-(p-tertiary butylphenoxy)-alpha methyl ethyl sulphite; wettable powder. Naugatuck Chemicals, Elmira, Ont.
4 Para-chlorophenyl phenyl sulphone; wettable powder. Stauffer Chemical Company, North Portland, Ore.
5 DN Dry Mix No. 1; wettable powder. Dow Chemical Company, Midland, Mich.
6 Penco Malathion E-55; emulsifiable liquid. Pennsylvania Salt Manufacturing Company, Tacoma, Wash.
7 Naugathion; wettable powder. Naugatuck Chemicals, Elmira, Ont.

Evidence of parathion-resistant mites also appeared in 1953 in a Summerland orchard that had received an average of two sprays of parathion per year since 1949. In 1953, 15 per cent parathion at 8 pounds per acre, applied in the pink bud stage, and 55 per cent malathion emulsifiable liquid at 4 pints per acre, applied in July, failed to control the European red mite. Normally, malathion at that rate controls the European red mite satisfactorily. A small experiment was carried out in this orchard to determine the relative value of parathion and of 19 per cent Mildex against the malathion-resistant mites. Mildex gave fair control, but parathion was entirely unsatisfactory (Table II).

A resistant strain of the European red mite also appeared in an orchard in the Penticton area. Fifty-five per cent malathion at two-thirds of a pint per 100 gallons, applied by hand-gun sprayer, did not control the mite, whereas 40 per cent Sulphenone at 3 pounds per 100 gallons did.

**Table II.—Average Numbers of the European Red Mite per Leaf[1] before and after Applying Acaricides by Hand-gun Sprayer in August, 1953**

| Acaricide | Amount per 100 Gal. | Before Spraying, Aug. 5 | After Spraying, Aug. 11 |
|---|---|---|---|
| Mildex, 19%[2] | 1 lb. | 28 | 4 |
| Parathion, 15%[3] | 1 lb. | 29 | 72 |
| Check, no treatment | ------- | 14 | 34 |

[1] Based on twenty leaves from each of two trees.
[2] Dinitro caprylphenyl crotonate and related nitrogen derivatives; wettable powder. Larvacide Products Incorporated, New York, N.Y.
[3] Naugathion; wettable powder. Naugatuck Chemicals, Elmira, Ont.

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## SCIENCE NOTE

### Note on Seed Production from Onion Bulbs Dipped in Insecticides at Planting

As the feeling that onion-seed crops were being damaged by maggots had persisted among growers in British Columbia, in 1953 tests were conducted to determine whether treatment of bulbs with insecticides immediately before planting affected: (*a*) The growth of the onion plants; (*b*) the amount of damage inflicted by the maggots, *Hylemya antiqua* (Mg.) and *Paragopsis strigatus* (Fall.); and (*c*) the subsequent yield and germination of the seed. The two species of flies were the most abundant of those collected over caged onion plants in the seed-fields at Grand Forks in 1950.

A farm at Kelowna where seed of the variety Yellow Globe Danvers No. 55 had been grown for many years was selected as the site for the tests. The experiment was conducted in randomized blocks with ten treatments, each replicated four times. Each plot consisted of one row 25 feet long; there were 36 inches between rows.

Treatments were 5 per cent slurries and 0.1 per cent emulsions of aldrin, DDT, dieldrin, and lindane. Bulbs were dipped in the slurries for five minutes and in the emulsions for thirty minutes. Slurries were prepared from wettable powders and emulsions from emulsifiable concentrates.

Two series of untreated plots were included; the bulbs for one were dipped in water for five minutes, for the other thirty minutes. These correspond to the periods of immersion for the slurry and emulsion treatments and compensate for any differences that might arise from the added moisture of the dip treatment. Eighty-five bulbs were planted in each plot. Counts were made of onion leaves two weeks after initial growth was observed. Periodic examinations were made throughout the season for phytotoxic symptoms and maggot damage.

All the seed-balls were harvested from each plot, stored in sacks until dry, threshed, blown, screened, and then weighed for seed yield. Four samples of 100 seeds each were taken from each treatment, placed on two thicknesses of filter paper in a closed petri dish, and allowed to germinate in a constant temperature cabinet at 78° F. Counts were made from the second to fourteenth day. Water was added when needed.

Analysis of variance showed no significant difference in growth, seed yield, or germination of onion seed produced. The average number of plants per treatment produced from the eighty-five bulbs per plot ranged from 79.7 to 84.2; the average seed yield ranged from 728.0 to 934.8 gm.; and the average percentage germination of the seed produced ranged from 95.7 to 98.0 per cent. No maggot injury was recorded in the experiment, although up to 35 per cent damage was recorded in near-by fields of onions grown from seed.

It must be assumed that the chemical treatment of the onion bulbs before planting had little or no effect on growth of the plants, or yield or germination of the seed.—*D. G. Finlayson, Field Crop Insect Section, Entomology Laboratory, Canada Department of Agriculture, Kamloops, B.C.*

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## HISTORICAL NOTE

While sorting the late Dr. E. C. Van Dyke's correspondence, I came upon a letter from Dr. H. A. Scullen of the Oregon Agricultural College at Corvallis, dated February 7, 1928. The following quotation may be of interest for the Entomological Society of British Columbia historical file:—

" Recently I was talking to Professor Livingston of our Department of Geology and found that his father was one of the early collectors in the region of Vancouver Island. His name was Clermont Livingston. Professor Livingston tells me that his father's collection consisted principally of Lepidoptera and Coleoptera collected since 1891 and is deposited with the Government House Museum at Victoria, B.C."—*Hugh B. Leech.*

# A LIST OF HYMENOPTERA COLLECTED AT ROBSON, B.C.

H. R. Foxlee
Robson, B.C.

## Family BRACONIDÆ

*Earinus limitaris* (Say), March, April.
*Atanycolus anocomidis* Cush., 1 VI 41, 22 VI 41.
sp., 10 VII 41.

## Family ICHNEUMONIDÆ

*Scambus pterophori* (Ash), 1 VI 46.
sp., 10 X 51.
*Ephialtes imperator* (Kriech), 13 VII 41.
*manifestator* (L.), 13 VI 41.
sp., 22 X 41.
*Zaglyptus varipes incompletus* (Cresson), 4 IX 51.
*Perithous pleuralis* Cress., 4 IX 51.
*Pimpla pedalis* (Cress.), 11 IV 41, 1 VII 51.
*aquilonius* (Cress.), 28 IV 46.
*sanguinipes* (Cress.), 24 VIII 41.
*Itoplectis 4-cingulatus* (Provancher), 5 VI 39, 2 X 39.
*Rhyssa alaskensis* Ash., 9 VII 39, 1 VI 46.
*lineolata* (Kirby), May.
*Rhyssella nitida* (Cresson), 26 V 46.
*Megarhyssa nortoni nortoni* (Cress.), 2 VI 46.
*Xorides californicus* (Cress.), 22 VI 39.
*cincticornis* (Cress.), 30 VII 39, 3 IX 51.
harringtoni (Rohwer), 13 VIII 39.
*Odontocolon* sp., 2 VI 40.
*Coleocentrus occidentalis* Cress., 22 VI 41, 4 VII 49.
*Netelia* (*Parabatus*) *deceptor* (Morley), 3 VIII 39.
*Tryphon* (*Symbœthus*) *communis communis* Cress., 19 V 51.
*seminiger* Cress., 19 V 51.
sp., 15 V 46.
*Exyston* sp., 16 VI 46.
*Alegina apantelis* (Cush.).
*Endasys subclavatus* (Say).
*Phygadeuon* sp., 1 VI 41.
*Cubocephalus canadensis* (Provancher), 10 VIII 41.
sp., 15 V 40.
*Polytribax* sp., 21 IX 41.
*crotchii* (Cresson), 27 V 46.
*Rhembobius abdominalis pacificus* (Harr.), 8 IV 42.
*Cryptus altonii* Dalla Torre, 7 IX 41, 1 VII 46, 5 X 41.
*luctuosus* (Cresson), 14 IX 41.
*perplexus* (Cresson), 28 IX 41, 16 IX 41.
*Mesostenus thoracicus* Cress., 22 VI 41.
*Trychosis* sp., 1 VI 41.
*Idiolispa* sp., 20 V 46, 1 VII 46.
*Hoplocryptus notatus* (Prov.), 28 VII 46.
*Polistiphaga fulva* (Cress.), ♂ 7 IX 41, ♀ 31 VII 41, 17 VIII 41.
*Acroricnus stylator niger* Mitchell, May, June, July, August.
*Platylabus clarus* (Cresson), 27 VI 41, 17 VIII 53.
*pedatorius* (Fab.).
*Melanichneumon* sp., 24 VIII 41.
*Pseudamblyteles subfuscus* (Cress.), 7 IX 41.
*variegatus* (Cresson), 17 VIII 41, 7 IX 41.
*Amblyteles nubivagus* (Cresson), 21 VII 43.
*Ichneumon lætus* (Brullé), 3 VIII 51.
sp., ♂ 24 VII 41.
sp., 3 ♂ ♂ 7 IX 41.
sp., ♂ 14 IX 41.
sp., ♂ 13 VII 41.
*Cœlichneumon orpheus* Cress., 21 IX 41.
*Conocalama occidentalis occidentalis* (Cresson), 1 VII 42.
*Glypa phoxopteridis* Weed, 13 VIII 39, 27 VII 51, 4 IX 51.
*simplicipes* Cress.
sp., 3 VIII 51.
*Amersibia superba* (Provancher), May.
*Arenetra* sp., 23 III 47.
*Lissonota montana montana* (Cresson), 7 IX 41.
sp., 21 IX 41.

*Pimplopterus frigidus* (Cress.), 7 IX 41.
sp., 21 IX 41.
*Pimplopterus parvus* (Cresson), 25 IV 51.
*Syzeuctus eximius* Walley, 6 VII 46.
*Exetastes crassisculptus* Cushman, April, May.
*ridens* Cushman, May.
*ruficoxalis* Cushman, 9 IX 40.
*Banchus canadensis,* Cress., May, June.
*superbus* Cress., April, May.
3 sps. probably, June, July.
*Euceros* sp., 13 VII 41.
*Ctenopelma* sp., 16 V 45.
*Opheltes glaucopterus flavipennis* (Provancher), 1 VII 42.
*Synœcetes festivus* (Cress.), 19 V 51.
*Himerta flavida* (Davis), 1 VI 41, 5 VII 51.
*Mesoleius submarginatus* (Cresson), 23 VI 46.
*tenthredinis* Morley, 1 VII 51.
sp., 29 V 51.
*Hadrodactylus coxatus* Davis.
*Euryproctus* sp., ♂ 2♀♀ 21 IX 41, 9 IX 51.
*Cylloceria sexlineata* (Say), 1 VI 41.
*Diplazon lætatorius* (Fab.), 29 VII 51.
*Syrphoctonus* sp., 5 X 41.
*Chorinæus* sp., 17 IV 51.
*Leurus* n. sp.
*Triclistus fulvipes* (Cress.).
*Exochus flavifrontalis* Davis, 6 IX 41.
*Campoplex validus* (Cresson), 5 V 46.
*Campoletis atypicus* (Vier), 3 V 51.
*Campoletis* sp., 1 VI 41.
sp., 5 V 51.
*Phobocampe* sp., 10 V 51.
*Horogenes acutus* (Vier.), 7 IX 41.
*Anomalon reticulatum* (Cress.), 24 VIII 41.
sp., 2♂♂ 24 VIII 41.
*Aphanistes* sp., 2 VI 46.
*Gravenhorstia* sp. No. 1, April, May, July.
*Gravenhorstia* sp. No. 2.
*Gravenhorstia* sp. No. 3.
*Gravenhorstia* sp. No. 4.
*Labrorychus* sp., 1 VII 51.
*Therion circumflexum* (L.), 20 VII 41, 13 VII 41.
*morio* (Fab.), 6 VII 46, 16 VI 40.
near *nigrovarium* (Brullé), 13 VI 41.
*Ophion* sp., 3 V 51.
sp., 2 VI 46.
sp., 1 VII 51.
*Enicosphilus* sp. (probably three species), May, June, July.

FAMILY GASTERUPTIIDÆ

*Aulacostethus editus* (Cresson).
*foxleii* Townes.

## Acknowledgments

I wish to extend my grateful thanks to Dr. Stuart Walley, Division of Entomology, Ottawa; to Dr. H. K. Townes, Mutual Security Agency, Manila, Philippines; and to Mr. R. T. Mitchell, of the United States Fish and Wildlife Service, Laurel, Md., for determining all species listed in this paper. Without their kindly co-operation, it would not have been possible to write this list.

# INSECT POPULATION SAMPLING*

K. GRAHAM† AND R. W. STARK‡

## GENERAL CONSIDERATIONS

### Purpose of Sampling

Sampling has four main functions:—

1. The *qualitative* determination of what is present within an area. This includes insects of taxonomic interest, noxious insects, and biotic agents of control, such as parasites and predators.

2. The *quantitative* determination of the status of a population within the area. It is desired to know the population levels of a particular insect, its parasites and predators. These determinations may be required to estimate the efficacy of artificial control. When done empirically, this is limited in scope and application to occasions requiring an immediate decision for treatment purposes or where interest or funds are not sufficient to make more detailed studies. Generally speaking, these are inadequate for determining success or failure of a control operation.

3. Usually, and particularly with those insects of economic importance, it is not sufficient to know only the present status of a population. It is also necessary to know something of the *dynamics* of the population; that is, what the population trends are when successive generations are studied.

4. In widely distributed insect populations it is often desirable and necessary to investigate the *ecology* of the species. This might include zones of abundance according to the locality, merely as a fact, or the abundance related to specific conditions such as physical environment or biotic community.

These four functions cover, in a broad sense, all of the purposes of sampling. The fields of sampling of the greatest economic importance and subject to the most error and criticism are the quantitative methods. Certainly, those methods dealing with the dynamics of insect populations are of the greatest use. From these stem reliable estimates of present and future insect damage, decisions as to the necessity for control, and information important to the application of biological or artificial control.

It seems timely to review some of the commoner sampling problems encountered in various fields of entomology, and the premises and techniques on which reliable sampling is based. Without suitable sampling we cannot use the tools of statistical analysis to describe the character of variability, to prove the reliability of estimates, or to show the significance of apparent differences. Therefore, it is the purpose of this discussion to review briefly the above considerations and illustrate them with samples from workers in the various fields.

### Collection of Data

Everyone who studies insects has some need to sample even if it is in the empirical sense of the collector. Even he has to arrive at some decision as to the adequacy of a variable series. For example, most insects are not so constant morphologically that single specimens are truly representative of the species.

When it is a question of determining a population within a given natural universe and determining the mortality factors within it, the problems become much more complex. The most fundamental requirement is that *the sampling of a particular insect population must be resolved about the distribution and life-cycle of the insect involved.* There is no " universal " sampling method.

The environments of insects achieving economic importance comprise a tremendous variety, from onion-crops to mature

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forest stands, each of which has individual variations depending on age, density, site, shape, and other factors. In selecting the sampling technique to be followed, there are several factors to consider. At what stage in the life-cycle will it be easiest to sample, considering the eventual treatment of the data as well as more practical considerations such as economy. For example, nearly every insect has a stage that is more or less static. Samples taken during this stage lend themselves well to sound, and standard, statistical procedures in the treatment and interpretation of data. However, sampling of an immobile stage, although easier, may not be of sufficient value nor suited to the purpose of the investigation. This condition arises in artificial control programmes and where the expected trend from single sampling is desired.

A common problem is that populations, regardless of the stage sampled, are never distributed so uniformly throughout a sampling universe that a few observations can give a reliable indication of the average density. Obviously, neither mortality nor parasitism can be judged from single specimens. It is clear that there must be a compromise between the proportion of the sampling universe covered and the number of individuals examined (Oakland 1953). The spatial pattern of area coverage also affects the reliability of the estimate.

Accepting the fact that only an approximation of the truth must suffice, no matter how statistically sound, several problems are presented in seeking the nearest approximation to that truth with the greatest economy of facilities at hand. These are not so much in actual techniques as in the questions—where? how much? and how many?

## Treatment and Interpretation of Data

To understand fully the requirements of sampling, the patterns of variability within a sampling universe must be considered. Much emphasis has been given to the concept of random sampling because it eliminates conscious or unconscious bias. There are many circumstances in nature, however, which make unrestricted random sampling illogical, especially where major subdivisions in the environment can be defined. In ecological studies it is often most logical to retain some homogeneity in terms of common features of environment. Thus one may wish to relate populations to restricted forest stands, field crops, individual orchards, and physical environmental factors such as altitude and aspect. This is often referred to as *stratification of sampling;* that is, sampling with respect to known environmental variates. Sampling in that manner is purposive and it has been demonstrated that within the confines of the stratum, sampling randomization can be attained to eliminate bias.

In summary, within any sampling universe there are two conditions of sampling that must be satisfied. These have been stated by Yates (1949), who writes:—

"1. If bias is to be avoided, the selection of samples must be determined by some process uninfluenced by the qualities of the objects sampled and free from any element of choice on the part of the observer.

"2. If a valid estimate of sampling error is to be available each batch of material must be so sampled that two or more sampling units are obtained from it. These sampling units must be a random selection from the batch of material, and all the sampling units in the aggregate must be approximately the same size and pattern and must together comprise the whole of the batch of material."

Personal selection, such as a tendency to over- or under-estimate and a tendency to select for particular characteristics, biases the estimation of the mean, and the standard errors derived for these estimates are meaningless.

A word of caution is advisable. The form of analysis of the data depends upon the sampling method used and upon the proportion of the population sampled. This subject is too detailed to include here but is simply and adequately covered in the elementary text by Quenouille (1950).

It has been shown by various authors and is fully discussed in Quenouille that the arithmetic mean of a sample gives a more accurate value for the mean of the population than any other measure, and that the standard deviation will usually give a more accurate measurement of the scatter in a population estimate than any other value. Moreover, most of the properties of a sample can be found from its mean and standard deviation. However, it must be borne in mind, when presenting data, that other expressions of central tendency and scatter, such as the mode, quartiles, deciles, and range, may illustrate a point better.

There is a further point to remember when sampling. Because the objective is to establish the character of the population in general, an attempt is made to estimate the frequency distribution of that population. In biological work it is often possible to estimate the general form of the distribution from field observations prior to sampling and hence to find the type of distribution with a smaller sample.

A distribution which often occurs, but, alas, not so frequently in biological work, is the *normal distribution*. When this applies it is indeed fortunate, for the mean and variance can be used to determine *all* about the population. This is the perfect case, making it simple to present the proportions of observations between any two values in summary form. However, as was stated, this does not obtain frequently in biological populations. Much work has been done in the field of biometrics, and it is not intended here to present a capsule digest, since this would be impossible. All that can be hoped is to stimulate interest and provide references to satisfy that interest.

In biological work, particularly entomology, there have been several population distributions described to suit particular cases. These include Poisson, binomial, negative binomial, Fisher's logarithmic, Neymann's, Cole's, the Thomas double Poisson, and Polya's. In regard to these, attention is called to a recent article which is, in our opinion, the most valuable single contribution in this field in recent years. This is an article by C. I. Bliss and R. A. Fisher (1953). In addition to demonstrating with examples the fitting of this distribution, they illustrate its advantages by comparison with the major types of distributions in use. Furthermore, they supply the reference sources for them. The article is well written and easily readable by anyone with a basic grasp of statistics, and it indicates that the problem of non-random biological distributions is being attacked from the view-point of the man who is faced with the problem; viz., the biologist.

The importance of distributions in quantitative sampling work has arisen from the fact that the statistical tests for significance of data, and, more important, the comparison and interpretation of data such as the variance-ratio test, are largely based upon the normal distribution. To be able to assess and accurately compare the characteristics of a population that is not normally distributed, the distribution must be related in some way to the normal distribution. This brings up the use of *transformations* to fulfil the above requirement. This cannot be elaborated upon here, and again reference is made to more qualified sources. Quenouille contains an easily understandable discussion on the subject, and one other reference of value is the article by Churchill Eisenhart (1947).

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# FOREST DEFOLIATORS*

Forest-insect population studies during the past decade have shown increasing recognition of the fact that valid conclusions regarding population trends require measurements made within certain limits of accuracy. The value of population estimates and trends is obviously enhanced if these can be related to actual forest damage. Not only the populations of the destructive insects, but also those of their parasites and predators are important. Indeed, all the mortality factors, such as climatic extremes and disease must be accounted for in the most valuable population studies.

There are many examples in the literature of population sampling. De Gryse (1934) described the most important techniques extant in 1934, but there have been many important advances since that time. For illustrative purposes only, three examples are presented which will serve to demonstrate the methods involved and practical applications.

## European Spruce Sawfly

This example is drawn from the work of M. L. Prebble (1943), who determined populations of the European spruce sawfly in the Gaspé Peninsula. This exhaustive and detailed work discussed the general requirements of sampling forest insects, demonstrated the difficulties encountered in this particular study, and showed how they were surmounted. The conclusions, based on eight years of field data, pertain solely to the sampling methods applicable to the cocoon stage.

It has been mentioned that choosing the stage of insect to be sampled is of great importance. The most desirable objective is the sampling of all stages related to a common denominator. In the spruce-sawfly work, larval population studies were carried out, but the amount of work required seriously limited their applicability. However, they are of value for long-term ecological studies, such as will be mentioned in a later example. It was determined that the cocoon stage, spent in the moss and debris of the forest floor, was best suited for sampling. It gave the maximum information on sawfly populations as well as the various control factors operating against the cocoon stage. Furthermore, the forest floor constituted a sampling universe that could be statistically regulated.

Three techniques were tested. The first consisted of counts of cocoons in 2- by 2-foot quadrats spaced mechanically and uniformly within representative forest types, regardless of suitability of location of individual quadrats. The second, using the same size of quadrat, required their location in a restricted universe, which was defined as " the area of suitable ground cover lying under dominant and codominant spruce trees in the forest types selected for study." The quadrats had to lie within a ring-shaped band whose inner margin was a circle around the tree 1 foot from the trunk and whose outer margin was bounded by the outer edge of the vertical projection of the crown. The third method used the same restricted sampling universe but divided the quadrats into four equal subsamples. This was tantamount to quadrupling the number of samples in the statistical analysis, although it introduces certain disadvantages. The manner of devising the latter two methods indicated that an *a priori* knowledge of the distribution in the forest floor assisted in reducing the required number of samples.

The first technique was abandoned, as it was found from analysis that the variability was so high that the number of samples necessary to give an accurate estimate was beyond practical limits. Both the second and third methods proved usable, but disadvantages in statistical interpretation were found in each. Without elaborating on these, it was concluded that where successive samples were to be taken in the same plot, the second method was the better; i.e., using the tree as a sampling unit. This would be usual prac-

* This section written by R. W. Stark.

tice when we are interested in population fluctuations.

An interesting side investigation reported in this paper was a comparison of the variability between the efficiency of workers. Its purpose was to determine the advisability of applying a correction factor to account for missing cocoons. No correction was needed, but checks were necessary to bring the counts to a satisfactory degree of accuracy.

An additional reference of interest is the discussion by Butcher (1951) of forest-insect sampling problems with special reference to the larch sawfly, whose habit of overwintering in cocoons in the soil renders the sampling problem similar to that of the spruce sawfly.

### The Lodgepole Needle Miner

Intensive study of this insect began in 1948, and it was 1951 before adequate sampling methods were derived. Graham, in 1951 (1952), presented to this society the ecological aspects of the problem; therefore, only methodology will be discussed here.

Statistical analysis in 1951 demonstrated that early coverage of the outbreak in the National parks was almost empirical. However, this analysis did provide the *a priori* knowledge, so often useful, for more efficient work. It demonstrated the practicability of using the branch tip as a sampling unit and indicated how many samples would be required to give a sampling accuracy of 10 per cent. Because a leaf-mining insect was involved, choice of the stage to be sampled was not the difficult problem that it is with most open leaf-feeders.

In the summer of 1951 four branch tips from each of 105 trees were sampled to establish the sampling method. This number of trees was predetermined only approximately; sampling was continued until the error was below 10 per cent. The sampling was done with respect to altitude, and it was established, population-wise, that we may consider three sampling universes with respect to altitude and two with respect to pine-trees. This was established from an analysis of variance between crown levels (arbitrarily dividing the crown into upper and lower, the division at the midpoint) and three altitude levels—valley-bottom (approximately 5,000 feet), valley-bottom plus 750 feet, and plus 1,500 feet. In the Rocky Mountains the latter elevation is usually close to timber-line. From the analysis of these samples it was determined that the counts of live larvæ in the sampling unit of a five-year branch tip were acceptable, and that, for practical usage, four branch tips from approximately thirty trees would give absolute population estimates within 10 per cent accuracy (Stark, 1952(*a*)). This was applicable to all stages found in the needle, from first instar to pupæ. However, to compensate for extremely high values in the low infestation counts, a transformation of the data was required. The transformation was supplied by G. B. Oakland, of the Biometrics Unit, Ottawa, as $\sqrt{x+0.5}$, where $x$ is the individual sample. Analysis of the transformed data corroborated the assumption that the distribution was, in effect, normal. More important, use of the transformation made possible a new application of the sequential sampling technique (Stark, 1952(*b*)).

The sequential formulæ were supplied by Oakland for the normal distribution. This technique is proving extremely useful in lodgepole - needle - miner surveys. Briefly, it is sampling with no fixed sample size. Limits of infestation classes and tolerated error are set, and the appropriate formulæ are applied. What is arrived at is graphical (or tabular) limits composed of upper and lower acceptance levels. Sampling is continued until the cumulative sum of samples is smaller or larger than the acceptance levels, thereby falling into an infestation " class," i.e., light, medium, etc.

The first system set up for the needle miner was arbitrary. Classes were called light, medium, and heavy, and were set with respect to existing populations. It has since been possible to relate infestation classes to the amount of defoliation, and new limits for needle-miner sampling by this method are being established. This will greatly increase the value of this method as a survey tool.

### Spruce Budworm

Because of its complex life-history and habits, development of sampling methods for this forest defoliator has proved to be a most difficult problem. However, after years of research it has been largely resolved and is being dealt with fully in other papers now in the process of publication. Only a brief résumé of the problems involved and a few of the results will be given here.

It was found that the egg-masses of the budworm constitute a sampling unit that is satisfactory from points of view of ease of collection, examination, and statistical analysis. This was not true of the first two instars, particularly the first. In both instars there is considerable wandering and wind dispersal, and the first-instar larvæ hibernate in tiny well-concealed hibernacula. These factors do not permit direct field sampling. When counting was required, samples had to be brought into the laboratory, and the larvæ were forced to emerge. The third to sixth instars are open feeders, reasonably limited in movement. As these may be found together in the field, they are considered as one sampling stage. Similar direct sampling of pupal cases gives information on pupal mortality factors and, indirectly, on moth populations and sex ratio, since sex of the moth may be determined from empty, as well as sound, pupal cases.

The physical problems of sampling for budworm were also great. In large trees, when felling was resorted to, the loss of larvæ and particularly of pupal cases was often large enough to affect sampling accuracy. To surmount this the investigators resorted to sectional aluminium pole pruners and an extensible aluminium ladder. The use of these in sampling was described by Morris (1950).

One notable achievement is the relation of all stages of the insect to a common denominator, the mean number of individuals per 10 square feet of foliage surface. This permits direct comparisons of all stages, important in ecological studies, and also allows conversion of populations at any stage to estimates of absolute populations.

The sample branches are whole primaries, the width and length are measured, and the area estimated allowing for branch shape. Special sampling by vertical and horizontal crown sections was used to establish the distribution and variance of the population in the tree (Morris, 1949).

It is understood that a successful application of the sequential technique has been applied to the spruce budworm, based on a different distribution than that described for the needle miner.

These examples serve to illustrate the advancements made in sampling forest defoliators within the past decade. The pattern of scientific investigation has been similar in all three examples and gives promise that the problems in sampling which are fundamental to further studies of the causes of insect fluctuations may yet be resolved.

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# NOTES ON THE LIFE-HISTORY OF *HESPERIA COMMA* L. *MANITOBA* SCUD. (LEPIDOPTERA, RHOPALOCERA) ON VANCOUVER ISLAND

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The following notes are supplementary or confirmatory to what is known concerning the life-history of this skipper. I am not aware that the life-history has been worked out for the Vancouver Island representative of the species.

Ova can easily be obtained by confining a female under a sleeve of netting enclosing a tuft of grass. She will lay her eggs on the grass, netting, and the twigs supporting the net. One female thus confined laid forty eggs. Another group of three laid fifty eggs within a day or two.

**Egg.** — Size 1 mm. by 0.80 mm. Hemispherical, attached to the grass by the broad base; smooth, slightly depressed in micropylar area, and with fine microscopic reticulations. Colour, a dull chalky white.

The following notes were obtained by observing the development of one individual from egg to adult. A female was observed fluttering slowly about the grass in a neglected corner of my lawn in a manner very different from the usually swift and erratic flight common to the skippers. After a short time she settled well down at the base of a grass stem and, curving her ovipositor forward, made one or two trial thrusts before depositing an egg on the stem. She then fluttered a short distance away and repeated the process. I collected an egg and placed it in a glass tube where the subsequent metamorphosis took place.

As the larva developed very slowly during the early phases, the moults were not all observed with certainty, hence a chronological account follows:—

September 19, 1952. The egg, laid on dead grass stem, was placed in a glass tube for observation.

April 24, 1953. Egg hatched. Larva, 2 mm. in length; head very large in proportion to the rest of the body, jet black; body fairly stout, spindle-shaped, pale beige or putty colour.

April 29. Larva very sluggish but nibbles sparingly at the grass.

May 23. Length 4 mm. Since April 29 it seems to have had only one moult. It spends most of the time in a slight silken cell constructed among the grass blades, from which it makes sorties in search of food.

May 27. As before. I have to keep on changing the grass, very carefully placing the fresh food alongside the cell, as the larva does not venture far away.

June 5. Length, 5 mm. Head black, roughened with minute papillæ. The first thoracic segment very small and narrow and looks like a black ring round the body. Body putty-coloured, thickly dotted with tiny black papillæ. Prolegs black, claspers same colour as body. Two white spots on under-side between segments 10-11 and 11-12. Under the microscope these spots appear to be made up of finely shredded white scales.

July 1. Length, 8 mm. Probably in third moult. Although growing slowly, the larva is evidently in good condition. Colour and markings as before.

July 14. Length, 17 mm. Obviously growing faster as size increases; remains most of the time within its cell, which is enlarged to match growth.

July 18. Length, 20 mm. I saw the larva in the process of moulting. Colour is darker.

August 7. Length, 30 mm. Possibly the fifth moult. Head black with two light-coloured vertical marks on vertex. Surface of head roughened with minute papillæ, body smooth, dull buff colour.

August 11. Length, 30 mm.; width, 6 mm. Evidently in last moult. Body reddish, spiracles black.

August 16. Size as before. Body has a tinge of brownish-purple with an obscure dark dorsal line.

August 24. Pupated in the last larval cell. **Pupa:** Length, 20 mm.; width, 6 mm. Wing-cases bluish-black, abdominal segments a dull pink, each segment with a double row of transverse fuscous dashes. Cremaster a tuft of many outwardly recurved hooked hairs. The pupa reposed in the cell vertically, head uppermost.

September 17. Pupa much darker in colour, the transverse abdominal markings have become merged into the general ground colour.

September 19. **Imago** emerged from the pupa exactly one year from the day the egg was laid. The adult was a female, normal as to size and colour.

**Summary**

The skipper *H. comma* L. *manitoba* Scud. passed a period of seven months in the egg stage, i.e., September 19, 1952, to April 24, 1953. The larval period required four months; growth was remarkably slow in the early stages. When feeding, the larva never went far from its silken cell unless the food-supply ran out, then it built a new cell among fresh growth, *Lolium* and *Bromus* sp.

I was unable to ascertain what function, if any, the four white spots on the underside of the larva may fulfil, although they seem to be of a structural nature rather than due to pigmentation. Could they be scent glands?

The pupal stage lasted for one month, and the pupa was enclosed in the old feeding tent of the larva, an unusual feature in butterfly pupæ.

# CHEMICAL CONTROL OF APHIDS IN BRITISH COLUMBIA ORCHARDS*

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Field experiments were conducted from 1947 to 1953 on the chemical control of the following aphids that attack tree fruits in the Interior of British Columbia: The black cherry aphid, *Myzus cerasi* (F.); the mealy plum aphid, *Hyalopterus arundinis* (F.); the thistle aphid, *Anuraphis cardui* (L.); the green peach aphid, *Myzus persicæ* (Sulz.); the apple aphid, *Aphis pomi* Deg.; and the woolly apple aphid, *Eriosoma lanigerum* (Hausm.). The work was done primarily to keep the pest-control calendar up to date in aphid-control.

## Sprays Directed against Overwintering Eggs

Since 1944 a spray of heavy dormant oil with DNOC or DNOCHP has been recommended in the Interior of British Columbia for the control of orchard aphids that overwinter in the egg stage. O'Kane and Baker (1935) have shown that oils kill aphid eggs by penetrating the egg-shell rather than by suffocation. Consequently, tests were conducted on a dormant application of other insecticides dissolved in dormant oil. In 1948 and 1949 a series of experiments with high-volume hand-gun sprayers on the control of the mealy plum aphid and the thistle aphid on prune-trees and the black cherry aphid on cherry-trees showed that parathion-dormant oil and BHC-dormant oil were just as effective against these aphids as the standard treatment of DNOC (or DNOCHP)-dormant oil. The results of a typical experiment are shown in Table I.

In some experiments, parathion alone, 0.75 pound of 15 per cent wettable powder per 100 gallons, applied at the dormant stage of bud development, also gave very good aphid-control (Table IV).

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**Table I.—Numbers of Colonies of the Black Cherry Aphid on Bing and Lambert Cherry-trees after a Dormant Oil Spray Containing Parathion, BHC, or DNOCHP**

| Material | Amount per 100 Gal. | Colonies per 10 Trees 67 Days after Spraying |
|---|---|---|
| Parathion, 15% wettable powder[1] | 1 lb. | 0 |
| Dormant oil[2] | 1 gal. | |
| Soya-flour[3] | 1 lb. | |
| BHC, 10% gamma isomer, wettable powder[4] | 0.25 lb. gamma isomer | 3 |
| Dormant oil | 1 gal. | |
| Soya-flour | 1 lb. | |
| DNOCHP, 40% wettable powder[5] | 1.5 lb. | 4 |
| Dormant oil | 1 gal. | |
| Soya-flour | 1 lb. | |
| Check | No spray | 137 |

1 American Cyanamid Company, New York, N.Y.
2 Approximately 220 S.S.U. Vis. 100° F., 65 per cent U.R. Shell Oil Company, Penticton, B.C.
3 Sprasoy. Glidden Paint Company, Chicago, Ill.
4 Pennslyvania Salt Manufacturing Company, Tacoma, Wash.
5 2-cyclohexyl-4,6-dinitrophenol. Dow Chemical Company, Midland, Mich.

Although parathion, alone or with dormant oil, and BHC-dormant oil were just as effective as the dinitro compounds with dormant oil, they were not recommended for aphid-control because the dinitro-oil formulations have the additional advantage of being effective against overwintering larvæ of the eye-spotted bud moth, *Spilonota ocellana* (D. & S.) and overwintering stages of some species of orchard mites.

### Sprays Directed against Nymphs and Adults

**Parathion.** — For many years the recommended spray for the summer control of several species of orchard aphids in British Columbia was nicotine sulphate mixed with soap or summer oil. However, with high-volume hand-gun spraying, nicotine did not always give satisfactory control. Consequently, when parathion became available, it was compared with nicotine for the control of several species of aphids.

Light to medium infestations of the mealy plum aphid on prune-trees were controlled more satisfactorily with parathion than with nicotine sulphate-soap (Table II), but the entomologists and a number of growers found that neither of these sprays gave satisfactory results when the aphid infestation was severe (Morgan and Downing, 1950).

**Table II.—Percentage Mortalities and Numbers of Colonies of the Mealy Plum Aphid on Italian Prune-trees after a Summer Spray of Parathion or Nicotine Sulphate**

| Material | Amount per 100 Gal. | Per Cent Mortality | | Average Number of Colonies per Tree | |
|---|---|---|---|---|---|
| | | Orchard 1[1] | Orchard 2[2] | Orchard 3[3] | Orchard 4[4] |
| Parathion, 15% wettable powder[5] | 0.75 lb. | 100 | 100 | 0.0 | 0.3 |
| Nicotine sulphate, 40% liquid[6] | 0.75 pt. | 99 | 85 | 0.5 | 6.8 |
| Soap[7] | 3.0 lb. | | | | |
| Check | No spray | 9 | 15 | 6.0 | 22.0 |

1 Based on 1,500 aphids per treatment, forty-eight hours after spraying. Four trees per treatment.
2 Based on 1,000 aphids per treatment, ninety-six hours after spraying. Three trees per treatment.
3 Based on sixteen trees per treatment, thirty-one days after spraying.
4 Based on four trees per treatment, twenty-four days after spraying.
5 Canadian Industries Limited, Montreal, Que.
6 The N. B. Bartlett Spray Works, Beamsville, Ont.
7 Rinso. Lever Bros., Montreal, Que.

In an experiment on the control of a severe infestation of the thistle aphid on prune-trees, parathion and nicotine sulphate-soap, used at the same dosages as in Table II, each killed over 99 per cent of the aphids when the sprays were applied during the summer by high-volume hand-gun machine.

Table IV shows that, with high-volume hand-gun spraying, parathion gave better control of the black cherry aphid than nicotine sulphate-soap when the sprays were applied at 95 per cent petal-fall of cherry. The superiority of parathion over nicotine sulphate-soap for the control of this aphid was even more evident in summer applications. For example, forty-nine days after spraying by high-volume hand-gun machine, the average number of aphid colonies or infested twigs per tree was forty-five in the nicotine plot but only five in the parathion plot.

In one experiment, with a high-volume hand-gun machine, the green peach aphid was controlled as satisfactorily with 15 per cent parathion, 1 pound, as with 40 per cent nicotine sulphate, 1 pint, plus washing soda, 0.5 pound, per 100 gallons of spray. In another experiment, with a high-volume hand-gun machine and with a semi-concentrate machine, neither parathion nor nicotine was satisfactory against the green peach aphid. Control was somewhat better with high-volume spraying than with semi-concentrate spraying. Poorer results in the second experiment were partly due to unfavourable weather; the temperature was relatively low (60° to 65° F.), it was windy, and rain fell before the spray deposits were dry.

Parathion gave rather good control of the woolly apple aphid when used at 1 pound of 15 per cent wettable powder per 100 gallons, but was much less effective at 0.5 pound. Control was improved by the addition of stove oil or summer oil. For example, in one experiment with a concentrate sprayer, parathion, at 3 pounds of 25 per cent wettable powder per acre, alone and with stove oil at 2 gallons per acre, was compared with 40 per cent nicotine sulphate, 1 gallon, plus summer oil, 2 gallons, per acre. Five days after spraying, the average number of aphids per internode was: Nicotine sulphate-summer oil, 0.1; parathion-stove oil, 0.2; parathion, 4.7; check, 286.4.

Parathion proved much more injurious to predacious coccinellid and syrphid larvae than nicotine sulphate, and was very toxic to aphid parasites. In a field experiment on the control of the black cherry aphid, parathion was applied by high-volume hand-gun sprayer at 0.75 pound of 15 per cent wettable powder per 100 gallons. Forty-eight hours after spraying, the parathion deposit remaining on the bodies of the aphids was sufficiently high to prevent emergence of the hymenopterous parasites *Aphidius testaceipes* (Cress.) and *Ephedrus nitidus* Gahan;* the parasites, in trying to emerge from the aphid hosts, received enough parathion on their mouth parts and antennæ to kill them even before they could get their heads outside the host " shells." At ninety-six hours after spraying, the parasites did emerge, but after moving about on the sprayed cherry foliage for about one hour they became moribund and soon died.

As a result of these and other field experiments on aphid-control, 15 per cent parathion wettable powder was recommended in 1950 at 1 pound per 100 gallons as a dilute spray, or 8 pounds per acre as a concentrate spray, as an alternative to nicotine sulphate-soap for the summer control of the mealy plum aphid and the woolly apple aphid. To prevent the occurrence of toxic residues on mature fruit, growers were advised to apply parathion no later than one month before harvest. It was not recommended as a summer spray for the control of the black cherry aphid because cherries are picked so early in the season that such a spray might give excessive residues at harvest.

In 1953 parathion was removed from the British Columbia pest-control calendar because of its high toxicity to man. It was replaced by another but less hazardous organic phosphate—malathion.

**Malathion.**—In 1952 malathion, applied by high-volume hand-gun machine or by concentrate machine, gave better aphid-control than any other aphicide then recommended in the spray calendar. In an Italian-prune orchard, with concentrate spraying, 25 per cent malathion, 16 pounds per acre, was compared with 40 per cent nicotine sulphate, 1 gallon, plus washing soda, 4 pounds, for the control of the mealy plum aphid. Three days after spraying, the average number of living aphid colonies per tree was: Malathion, 0; nicotine sulphate-washing soda, 5; check, 63. In an apple-orchard, concentrate sprays of malathion and nicotine sulphate-washing soda, at the same dosages as above, were compared for the control of the apple aphid. Three days after spraying, the average number of winged aphids per 250 leaves was: Malathion, 5; nicotine sulphate-washing soda, 42; check, 127. Control in this experiment was considerably better than the figures indicate, for the ratio of alate to apterous forms was much greater on the sprayed trees than on unsprayed trees. In an experiment on the control of the

* Determined by G. S. Walley, Entomology Division, Ottawa.

green peach aphid with high-volume spraying, no living aphids were found five days after applying 25 per cent malathion, 2 pounds per 100 gallons; a few aphids were alive on trees sprayed with 15 per cent parathion, 1 pound, or with 40 per cent nicotine sulphate, 1 pint, plus washing soda, 0.5 pound. Other experiments showed that malathion readily controlled the woolly apple aphid and the thistle aphid; it was also most effective against the black cherry aphid, but, in some instances, injured cherry foliage.

Malathion, like parathion, was much more injurious to predacious coccinellid and syrphid larvæ than nicotine sulphate. Consequently, where malathion is not required for mite-control, it is advisable to use nicotine sulphate to control light to medium aphid infestations; severe aphid infestations may require malathion.

**Nicotine Sulphate plus Washing Soda.** — The standard recommendation of nicotine sulphate plus soap could not be used effectively with concentrate sprayers because of excessive foaming from the soap. It was found, however, that washing soda could be used in the place of soap to liberate the nicotine. Nicotine sulphate-washing soda gave satisfactory control of orchard aphids whether it was applied by concentrate or by high-volume hand-gun machines. For example, three days after spraying a severe infestation of the mealy plum aphid on prune-trees with a concentrate machine, the average number of living aphid colonies per tree was: 40 per cent nicotine sulphate, 1 gallon, plus washing soda, 4 pounds, per acre, 5 colonies; check, 63 colonies. In another prune-orchard, lightly infested with the mealy plum aphid, no aphids were found alive four days after high-volume hand-gun spraying with 40 per cent nicotine sulphate, 1 pint, plus washing soda, 0.5 pound, per 100 gallons of spray.

As a result of these and other field experiments, nicotine sulphate-soap was replaced by nicotine sulphate-washing soda in the 1952 spray calendar.

**Table III.—Effect of Polyethylene Glycol Ester of Oleic Acid on the Toxicity of Nicotine to the Mealy Plum Aphid on Italian Prune-trees**

| Material | Amount per Acre | Average Number of Living Aphid Colonies per Tree[1] |
|---|---|---|
| Nicotine alkaloid, 40% liquid[2] | 1 qt. | 10 |
| Nicotine alkaloid, 40% liquid<br>Polyethylene glycol ester of oleic acid[3]<br>Silicone,[4] 1 part; stove oil,[5] 2 parts | 1 qt.<br>1 qt.<br>0.6 oz. | 10 |
| Nicotine sulphate, 40% liquid[2]<br>Washing soda[6] | 1 qt.<br>1 lb. | 13 |
| Nicotine sulphate, 40% liquid | 1 qt. | 15 |
| Nicotine sulphate, 40% liquid<br>Polyethylene glycol ester of oleic acid<br>Silicone, 1 part; stove oil, 2 parts | 1 qt.<br>1 qt.<br>0.6 oz. | 21 |
| Check | No spray | 63 |

1 Based on three trees per treatment, three days after spraying.
2 Tobacco By-products & Chemical Corporation, Louisville, Ky.
3 Glyco Products Company, Inc., Brooklyn, N.Y.
4 Antifoam preparation. Dow-Corning Products Division, Fiberglass Canada Limited, Toronto, Ont.
5 Approximately 34 S.S.U. Vis. 100° F., over 75 per cent U.R. Shell Oil Company, Penticton, B.C.
6 Sodium carbonate ($10H_2O$). Church & Dwight Company, Montreal, Que.

**Nicotine plus Polyethylene Glycol Derivatives.**—Wigglesworth (1945) and Turner *et al.* (1951) showed in laboratory work that certain polyethylene glycol derivatives enhanced the toxicity of nicotine. However, field experiments conducted by the Summerland entomologists in 1952 indicated that polyethylene glycol esters of oleic acid and tall oil did not measurably increase the toxicity of nicotine sulphate or nicotine alkaloid to many species of orchard aphids, whether the sprays were applied by high-volume hand-gun machine or by concentrate machine. The results of one of these experiments, with a concentrate machine, are shown in Table III.

**BHC and Lindane.**—In 1947 BHC was mentioned in the British Columbia spray calendar for the control of various species of orchard aphids. As Morgan (1947) proved that the toxicity of BHC was enhanced when it was used with oil, the recommendation was changed in 1948 to BHC plus distillate oil, stove oil, or summer oil. Growers were warned not to apply BHC later than one month before harvest, because this insecticide gives fruit an objectionable flavour when it is applied too close to picking-time (Proverbs 1948).

Experiments in 1947 and 1948 showed that control of the woolly apple aphid was much improved by increasing the BHC dosage from one-eighth to one-quarter of a pound of gamma isomer per 100 gallons of spray. However, the recommended dosage of one-eighth of a pound was not increased, as this would have probably resulted in tainted fruit.

Lindane, like BHC, gave better control of aphids when used with oil than when used alone. For example, 25 per cent lindane, 0.5 pound per 100 gallons of spray, was compared with an equal quantity of lindane mixed with 0.5 gallon of stove oil for the control of the woolly apple aphid. Four days after spraying, with a high-volume hand-gun machine, the average number of aphids per internode was: Lindane-stove oil, 1.7; lindane alone, 11.0; check, 350. In another orchard no living woolly apple aphids were found five days after concentrate spraying with 50 per cent lindane, 2 pounds, plus summer oil, 1 gallon, per acre; aphids were abundant on check-trees when the mortality counts were made.

Although lindane does not taint fruit as much as BHC, it has not been recommended because of its prohibitive cost.

**Other Insecticides.** — In 1949 and 1950 HETP gave good control of the apple aphid and the woolly apple aphid. For example, four days after high-volume hand-gun spraying with 50 per cent HETP, 1 pint per 100 gallons, the average number of woolly apple aphids per internode was 0.1, in comparison with 350.0 on unsprayed trees. HETP, however, was not recommended to growers because it injured some varieties of apple and pear, besides being quite as dangerous to handle as parathion.

Forty per cent Pyrolan,* 2 quarts per acre, or Endrin,† 18.5 per cent, 1 quart, or Isodrin,‡ 18.5 per cent, 1 quart, applied by concentrate machine, gave good initial mortality of the woolly apple aphid in a McIntosh-apple orchard. Six weeks later many aphids were present on the trees sprayed with these materials, whereas no living aphids were found on trees sprayed with 50 per cent malathion, 6 pounds per acre. In another experiment, where the dosage of Pyrolan, on an acreage basis, was approximately doubled, very good control of the mealy plum aphid was obtained on apricot-trees with a high-volume hand-gun sprayer. In view of the variable results with Pyrolan, it should be further tested as an aphicide.

In 1952 a concentrate spray of Pyrenone T-503§ at 1 gallon per acre did not give satisfactory control of the apple

* Emulsifiable liquid. 1-phenyl-3-methyl-pyrazolyl-(15)-dimethyl carbamate. Geigy Co. Inc., Bayonne, N.J.

† Emulsifiable liquid. Hexachlor-epoxy-octahydro-endo-endo-dimethano naphthalene. Shell Chemical Corporation, Julius Hyman Division, Denver, Colo.

‡ Emulsifiable liquid. Hexachloro-hexahydro-endo-endo-dimethano naphthalene. Shell Chemical Corporation, Julius Hyman Division, Denver,Colo.

§ Emulsifiable liquid. Pyrethrins 0.4 per cent w/v, rotenone 2 per cent w/v, piperonyl cyclonene 4 per cent w/v. U.S. Industrial Chemicals, Baltimore, Md.

aphid on Stayman apple-trees. Results with this material varied when it was used to control the mealy plum aphid. In an Italian-prune orchard, where the spray was applied by concentrate machine at the same dosage as above, the average number of living aphid colonies per tree three days after spraying was: Pyrenone, 5; check, 63. However, in an apricot-orchard that was sprayed with a high-volume hand-gun machine, Pyrenone, 1 pint per 100 gallons (approximately 1 gallon per acre), eliminated only 6 per cent of the aphid colonies. Differences in control in the last two experiments might be due, in part, to the methods of spraying.

The systemic insecticide Isopestox* gave very good control of the woolly apple aphid on McIntosh apple-trees when applied a few weeks before harvest by concentrate machine at 6 pounds of technical crystals per acre. Experiments with this insecticide were discontinued when it was learned that it was very much more injurious to man than was at first believed.

* Bis(isopropylamino)fluorophosphine oxide. Pest Control Ltd., Bourn, Cambridge, England.

Another systemic insecticide, schradan, applied by concentrate sprayer at 1 gallon of 63.3 per cent emulsifiable liquid per acre, did not give satisfactory control of the apple aphid in a mixed planting of Delicious and McIntosh apple-trees. Ripper *et al.* (1950) have pointed out that schradan has very little value as a contact insecticide, almost all of its potency being due to its systemic properties. Consequently, if the insecticide is improperly absorbed by the plant, as is often the case with mature plants, sap-sucking insects may not receive a lethal dose. This might account for the poor results in the foregoing experiment, for the insecticide was applied late in the season (August 14), when apple-trees were no longer growing rapidly.

## Dormant Sprays versus Petal-fall Sprays

British Columbia growers sometimes find it very difficult to apply dormant sprays on time because, in early spring, water for spraying is not readily available, orchards are often muddy, and there is

**Table IV.—Numbers of Colonies of the Black Cherry Aphid on Bing and Lambert Cherry-trees after a Dormant or Petal-fall Spray of Various Insecticides**

| Material | Amount per 100 Gal. | Stage and Time of Application | Colonies per Six Trees on May 18 |
|---|---|---|---|
| Parathion, 15% wettable powder[1] | 0.75 lb. | Dormant, Mar. 22 | 0 |
| Dormant oil[2] | 2.0 gal. | | |
| Soya-flour[3] | 0.5 lb. | | |
| Parathion, 15% wettable powder | 0.75 lb. | Dormant, Mar. 22 | 1 |
| Parathion, 15% wettable powder | 0.75 lb. | 95% petal-fall, May 3 | 2 |
| DNOC, 40% wettable powder[4] | 1.5 lb. | Dormant, Mar. 22 | 3 |
| Dormant oil | 2.0 gal. | | |
| Soya-flour | 0.5 lb. | | |
| Nicotine sulphate, 40% liquid[5] | 0.75 pt. | 95% petal-fall, May 3 | 14 |
| Soap[6] | 3.0 lb. | | |
| Check | No spray | | 37 |

1 Pennsylvania Salt Manufacturing Company, Tacoma, Wash.
2 Approximately 220 S.S.U. Vis. 100° F., 65 per cent U.R. Shell Oil Company, Penticton, B.C.
3 Sprasoy. Glidden Paint Company, Chicago, Ill.
4 2-methyl-4,6-dinitrophenol. Dow Chemical Company, Midland, Mich.
5 The N. M. Bartlett Spray Works, Beamsville, Ont.
6 Rinso. Lever Bros., Montreal, Que.

almost continuous wind. In 1949 an experiment was conducted to determine whether a petal-fall application was satisfactory as an alternative to the dormant spray for the control of the black cherry aphid. Dormant sprays of parathion, alone and with dormant oil, and DNOC-dormant oil were compared with petal-fall sprays of parathion and nicotine sulphate.

Table IV shows that the petal-fall application of parathion, which was timed to kill the aphids before the stem mothers had started to reproduce, gave just as good control as the dormant sprays, directed against the overwintering eggs. The petal-fall spray of parathion and the dormant sprays of parathion, parathion-dormant oil, and DNOC-dormant oil held the aphid populations at low levels for the remainder of the growing season, whereas in the nicotine sulphate plot the trees were severely infested with aphids at harvest-time.

As a result of this and similar experiments, parathion was recommended, in 1950 and 1951, at petal-fall as an alternative to the dormant spray of DNOC (or DNOCHP) plus dormant oil for the control of the black cherry aphid.

## Summary

Field experiments from 1947 to 1953 on the chemical control of aphids in British Columbia orchards gave the following results:—

1. Malathion was very effective against orchard aphids, and, in 1953, was recommended as an alternative to nicotine sulphate-washing soda for the summer control of all species except the black cherry aphid.
2. The black cherry aphid was controlled just as effectively with a petal-fall spray of parathion as with DNOC-dormant oil applied at the dormant stage of cherry-bud development.
3. During summer, parathion gave better control of the mealy plum aphid and the woolly apple aphid than nicotine sulphate-soap. From 1950 to 1952 it was recommended as an alternative to nicotine for the control of these species.
4. BHC-dormant oil and parathion-dormant oil, applied at the dormant stage of bud development, gave just as high mortality of the overwintering eggs of the mealy plum aphid, the thistle aphid, and the black cherry aphid as the usual treatment of DNOC (or DNOCHP)-dormant oil.
5. The toxicity of lindane was increased when the insecticide was used with oil. Although lindane does not taint the flavour of fruit as much as BHC, it was not recommended because of its prohibitive cost.
6. The systemic insecticide Isopestox was very effective against the woolly apple aphid. Schradan, another systemic insecticide, did not give satisfactory control of the apple aphid when applied about one month before harvest.
7. Polyethylene glycol esters of tall oil and oleic acid did not measurably enhance the aphicidal value of nicotine sulphate or nicotine alkaloid.
8. HETP gave good control of the apple aphid and the woolly apple aphid, but was not recommended because it injured some varieties of apple and pear.

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## BOOK REVIEW

*The Beetles of the Pacific Northwest, Part I: Introduction and Adephaga.* By Melville H. Hatch. Univ. Wash. Publications in Biology, Vol. 16, pp. 1–340. Sept., 1953. Univ. Wash. Press, Seattle 5, $5.

In this volume of 340 pages Professor Hatch has compiled an exhaustive survey of the beetles of Washington, Idaho, Oregon, and British Columbia—through "Adephaga." To students and collectors in these areas the book is invaluable, and to the continent at large there will be many surprises: so many unexpected species have turned up, and the supposed range of several rarities have been greatly extended.

The book opens with an inspiring introduction, followed by a history of what has gone before—the literature, the collectors, and their collections. There are able discussions on the structure of coleoptera, geographical factors. Within the covers we find a list of introduced species, with a first available record for each. There is an ample bibliography, and an index system that is as perfect as may be conceived. There are thirty-seven plates that are pleasing to look at and of real help in identifying our species.

In the text itself each group is preceded by a key, then the species described in more detail, with indications of range, etc. New species are described on the spot, thus pointing their positions. An important innovation is a complete bibliography of Northwestern references under each species.

To some it may be disconcerting that the placid system of classification we have been used to is somewhat disrupted: species are not where we expect to find them. Some of the synonyms may be disputed and some good species may have been relegated to lesser ranks. But (if the but exists) the book is packed with important information, and the amount of work and research that has gone into the making is beyond measure. We sense at once that the author is deeply interested in his subject, and he has presented his findings sincerely and without bias. The completeness of his system, perhaps foreshadowed by Blatchley, may well set a pattern for other States and Provinces to follow.

*G. Stace Smith.*

# CHEMICAL CONTROL OF THE PEACH TWIG BORER, *ANARSIA LINEATELLA* ZELL. (LEPIDOPTERA: GELECHIIDÆ), IN THE OKANAGAN VALLEY OF BRITISH COLUMBIA.*

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In the Okanagan Valley of British Columbia the peach twig borer, *Anarsia lineatella* Zell., has two complete generations per year. It overwinters as an immature larva in an excavation in the bark, usually in a crotch between 1- and 2-year-old wood. The larvæ leave their winter quarters at the balloon stage of peach flower-bud development. The overwintered larvæ, which in this paper are considered the first-generation larvæ, feed entirely in the twigs, but the second-generation larvæ feed also on the fruit.

Most fruit-growers in the Interior of British Columbia spray their peach and apricot trees every year for the control of the peach twig borer. Control measures are usually aimed against the first-generation larvæ. Lime-sulphur and sometimes lead arsenate were used for many years. Unfortunately, lime-sulphur sometimes injures apricot-trees, and lead arsenate is phytotoxic to both peach and apricot trees.

In 1947, 1948, and 1952 a number of new insecticides were tried for the control of the peach twig borer. Some of these were mixed with petroleum oil and applied at the delayed dormant stage of tree development to kill the larvæ in their winter quarters; others were applied, without oil, at the balloon-bud, petal-fall, or fall-of-husk stage to destroy the first-generation larvæ feeding on the twigs.

## Materials and Methods

**Delayed Dormant Sprays versus a Fall-of-husk Spray.**—In 1947, distillate oil-BHC, dormant oil-DNOC, and dormant oil-lime-sulphur were applied to apricot-trees at the delayed dormant stage and to peach-trees at the dormant stage. At the fall-of-husk stage, DDT was applied to about twenty of the untreated apricot-trees. The sprays were all applied with a high-volume hand-gun machine. On May 20, counts were made of the number of apricot twigs injured per six trees by the first-generation larvæ of the peach twig borer (Table I).

**Delayed Dormant Sprays versus Balloon-bud Sprays.**—In 1948, distillate oil-BHC, dormant oil-BHC, and dormant oil-lime-sulphur were applied to peach-trees at the delayed dormant stage with a high-volume hand-gun machine. An intermediate solvent (Velsicol AR-50) was added to the oil-BHC formulations to ensure rapid solution of the BHC. DDT and lime-sulphur were applied to a number of the untreated trees at the balloon stage of flower-bud development with a concentrate machine. Twelve days after application of the oil sprays, overwintered larvæ of the borer were cut out from the bark of sprayed and unsprayed trees to determine what percentage of them had been killed by the sprays. Fruits were examined, at harvest, to determine how many of them had been injured by the second-generation larvæ (Table II).

In another peach-orchard, the oil-BHC and oil-lime-sulphur sprays were applied at the delayed dormant stage, and lime-sulphur, DDT, and parathion at the balloon-bud stage. DDT and parathion were applied with a concentrate sprayer, and the other chemicals with a high-volume hand-gun machine. Fruits were examined at harvest, as in the previous experiment, to determine how many of them had been injured by the second-generation larvæ (Table III).

**Various Sprays Applied at the Delayed Dormant Stage.** — In a third peach-orchard, distillate oil-BHC, dormant oil-BHC, dormant oil-lime-sulphur, parathion, and DDT were applied at the

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delayed dormant stage with a high-volume hand-gun machine. Eleven weeks later, counts were made of the number of twigs injured by the first-generation larvæ, and, at harvest, fruits were examined to determine how many of them had been injured by the second-generation larvæ (Table IV).

**Balloon-bud Spray of DDT.** — In 1948, DDT, 50 per cent wettable powder at 2 pounds per 100 gallons, was applied with a high-volume hand-gun machine to about fifty apricot-trees at the late balloon-bud stage. One month later, sprayed and unsprayed trees were examined to determine the number of twigs injured by the first-generation larvæ, and, at harvest, fruits were examined to determine how many of them had been injured by the second-generation larvæ.

**Balloon-bud Sprays versus a Petal-fall Spray.** — In 1952 a balloon-bud spray of DDT was compared with a 90-per-cent petal-fall spray of DDT in a mixed planting of Veteran and Vedette peach-trees. Lime-sulphur and Systox (diethoxythiophosphoric acid ester of 2-ethyl mercapto-ethanol) were also applied at the balloon-bud stage. All the sprays were applied to duplicate plots with a concentrate machine. On May 26, records were made of the number of twigs injured by the first-generation larvæ, and, at harvest, fruits were examined to determine how many of them had been injured by the second-generation larvæ (Table V).

## Results and Discussion

Of all the sprays tested, DDT as a balloon-bud or petal-fall spray gave best control of the peach twig borer, being consistently more effective than the recommended treatment of lime-sulphur (Tables II to V). Table V shows that the first-generation larvæ injured twice as many twigs when DDT was applied at petal-fall as when applied at the balloon-bud stage, but the percentages of fruit injured by the second-generation larvae were approximately equal. Differences in twig injury are attributed to the larvæ having attacked some of the twigs before DDT was applied at petal-fall. The success of the petal-fall spray depends on the larval habit of feeding on several twigs. These results suggest that nurseries and young non-bearing orchards should be sprayed at the balloon-bud stage to control the borer before it can enter the twigs and spoil the shape of the tree; in bearing orchards, the petal-fall spray would be more economical, as it also controls *Lygus* bugs.

Where *Lygus* bugs are not a problem in bearing orchards, a number of growers are applying 10 per cent lime-sulphur early in the balloon stage of flower-bud development. This treatment has given satisfactory results against both peach leaf curl and the borer, although the dormant application is the one normally recommended for controlling the leaf curl disease.

On the basis of the number of injured twigs, DDT applied at the fall-of-husk stage had no effect on the borer (Table I). However, this was not necessarily so, for, when the spray was applied, most of the injured twigs were already tunnelled by larvæ. Unfortunately, the over-all effect of the spray could not be estimated at harvest from fruit injured by second-generation larvæ, as in all the plots, including the check, such injury was negligible.

A delayed dormant spray of dormant oil-lime-sulphur gave rather good control of the borer in three experiments (Tables I, II, and IV), but was unsatisfactory in a fourth (Table III). Poor control in the latter can be partly attributed to the exceptionally high borer population in that part of the orchard sprayed with oils. The degree of effectiveness of dormant oil-lime-sulphur was remarkable. Since this mixture controlled peach leaf curl, and is effective against the San Jose scale, *Aspidiotus perniciosus* Comst., it would be most useful if peach-trees in British Columbia were not susceptible to oil injury. Table II shows that larval mortality in the winter quarters was lower in the

**Table I.—Injuries Caused to Apricot-trees by First-generation Larvæ of the Peach Twig Borer after Various Delayed Dormant and Fall-of-husk Sprays, 1947**

| Material | Amount per 100 Gal. | Stage and Time of Application | Twigs Injured per Six Trees |
|---|---|---|---|
| Distillate oil[1] | 2 gal. | Delayed dormant, Mar. 12 | 8 |
| BHC wettable powder[2] | 0.24 lb. | | |
| 6% gamma isomer | Gamma isomer | | |
| Soya-flour[3] | 1 lb. | | |
| Dormant oil[4] | 1 gal. | Delayed dormant, Mar. 12 | 11 |
| Lime-sulphur[5] | 3 gal. | | |
| Soya-flour | 1 lb. | | |
| Dormant oil | 2 gal. | Delayed dormant, Mar. 12 | 16 |
| DNOC, 50% wettable powder[6] | 1.5 lb. | | |
| Soya-flour | 1 lb. | | |
| DDT, 50% wettable powder[7] | 2 lb. | Fall-of-husk, Apr. 25 | 101 |
| Check | No spray | ---------- | 71 |

1 42 S.S.U. Vis. 100° F., 77 per cent U.R. Imperial Oil Company, Sarnia, Ont.
2 Imperial Chemical Industries, England.
3 Glidden Paint Company, Chicago, Ill.
4 Approximately 220 S.S.U. Vis. 100° F., 65 per cent U.R. Imperial Oil Company, Ioco, B.C.
5 Specific gravity 1.28. Oliver Chemical Company, Penticton, B.C.
6 2-methyl-4,6-dinitrophenol. Niagara Sprayer & Chemical Division, Food Machinery Corporation, Middleport, N.Y.
7 The Sherwin-Williams Co. (Green Cross Insecticides), Montreal, Que.

dormant oil-lime-sulphur plot than in the oil-BHC plots, but the percentages of injured fruit were approximately equal. This suggests that lime-sulphur was still toxic when the larvæ emerged from hibernation.

Delayed dormant sprays of distillate oil-BHC and dormant oil-BHC gave satisfactory control of the borer in three orchards (Tables I, II, and IV), but were unsatisfactory in a fourth (Table III). It was in the fourth orchard that dormant oil-lime-sulphur gave poor control, and, again, failure can be partly attributed to the exceptionally high borer population initially present in that part of the orchard. According to Venables,* oil sprays are ineffective against the borer when the larvæ are in their winter quarters. Examination of hibernaculæ twelve days after application of a delayed dormant spray showed, however, that oil-BHC killed a large number of larvæ (Table II). If Venables's finding is correct, the oil simply acted as a penetrant and carrier for the toxicant. Though oil-BHC was rather effective in killing the overwintering larvæ, it has not been recommended in view of the excellent results from DDT applied as a dual-purpose treatment for the borer and *Lygus* bugs later in the season.

The mixture of dormant oil-DNOC-soyaflour gave satisfactory control of the borer (Table I), but could not be recommended because it caused bud injury to apricot-trees. Without soya-flour emulsifier, the spray was even more injurious to dormant peach-trees.

One experiment indicated that a balloon-bud spray of parathion gave good control of the borer (Table III), but because of the very light crop in that instance the results are not conclusive. Parathion applied at the delayed dormant stage appeared to be very effective when judged by the number of twigs injured by first-generation larvæ, but it was much less effective when judged by the percentage

* Venables, E. P. The peach twig borer or peach worm. Canada Dept. Agr., Entomological Laboratory, Vernon, B.C., mimeographed circular. 1940.

**Table II.—Mortalities of Overwintering Larvæ of the Peach Twig Borer, and Injuries Caused to Peach Fruit by the Second-generation Larvæ, after Various Delayed Dormant and Balloon-bud Sprays, 1948.**

| Material | Amount per 100 Gal. (or per Acre) | Stage and Time of Application | Larvæ Killed in Winter Quarters[1] | Fruit Injured[2] |
|---|---|---|---|---|
| | | | Per Cent | Per Cent |
| Distillate oil[3] | 1 gal. | Delayed dormant, Apr. 2 | 87.5 | 1.8 |
| Velsicol AR-50[4] | 1 pt. | | | |
| BHC wettable powder[5] | 0.25 lb. | | | |
| 10% gamma isomer | Gamma isomer | | | |
| Soya-flour | 1 lb. | | | |
| Dormant oil | 1 gal. | Delayed dormant, Apr. 2 | 92.6 | 1.3 |
| Velsicol AR-50 | 1 pt. | | | |
| BHC wettable powder | 0.25 lb. | | | |
| 10% gamma isomer | Gamma isomer | | | |
| Soya-flour | 1 lb. | | | |
| Dormant oil | 1 gal. | Delayed dormant, Apr. 2 | 45.5 | 1.1 |
| Lime-sulphur | 3 gal. | | | |
| Soya-flour | 1 lb. | | | |
| Lime-sulphur | 20 gal. (per acre) | Early balloon, Apr. 21 | ------- | 0.6 |
| DDT, 50% wettable powder | 16 lb. (per acre) | Early balloon, Apr. 21 | ------- | 0.0 |
| Check | No spray | ------------------------------ | 0.0 | 9.6 |

1 Based on twenty-five larvæ per plot.
2 Based on approximately 2,000 fruits taken at random from twenty trees in each plot.
3 38 S.S.U. Vis. 100° F., 75 per cent U.R. Shell Oil Company, Penticton, B.C.
4 A methylated naphthalene. Velsicol Corporation, Chicago, Ill.
5 Pennsylvania Salt Manufacturing Company, Tacoma, Wash.

of fruit injured by second-generation larvæ (Table IV). The high percentage of injured fruit in this instance was probably due to reinfestation by moths flying in from adjacent unsprayed trees. Experiments were discontinued with this promising insecticide when it was removed from the pest-control calendar because of its high toxicity to man.

The balloon-bud spray of Systox evidently gave satisfactory control of the borer (Table V), but this insecticide should be further investigated, for, generally speaking, Systox is not very effective against mandibulate insects.

In the experiment on the control of the borer on apricot-trees with a balloon-bud spray of DDT, examination of twenty of the trees, one month after spraying, showed that the first-generation larvæ had injured an average of 0.7 twigs per tree. Ten unsprayed trees showed an average injury of 7.7 twigs per tree. At harvest, however, no fruit was found injured by second-generation larvæ. Such results are not at all uncommon concerning the peach twig borer. Sometimes the hymenopterous parasite *Paralitomastix pyralidis* Ashm.* greatly influences the results. In 1948, 48 per cent of the second-generation larvæ were killed by this parasite in a Penticton orchard. A small percentage of injured fruit at harvest does not always mean that the borer population has been reduced. If the trees are growing rapidly, with an abundance of succulent terminal growth, most of the second-generation larvæ continue to feed in the twigs rather than attack ripening fruit. It is impractical to record the number of twigs injured by second-generation larvæ because of the density of mature foliage at harvest. Con-

* Determined by Dr. O. Peck, Entomology Division, Ottawa.

**Table III.—Injuries Caused to Peach Fruit by the Second-generation Larvæ of the Peach Twig Borer after Various Delayed Dormant and Balloon-bud Sprays, 1948**

| Material | Amount per 100 Gal. (or per Acre) | Stage and Time of Application | Fruit Injured[1] |
|---|---|---|---|
| | | | Per Cent |
| Distillate oil[2] | 1 gal. | Delayed dormant, Apr. 1 | 6.1 |
| Velsicol AR-50 | 1 pt. | | |
| BHC wettable powder | 0.25 lb. | | |
| 10% gamma isomer | Gamma isomer | | |
| Soya-flour | 1 lb. | | |
| Dormant oil | 1 gal. | Delayed dormant, Apr. 1 | 4.7 |
| Velsicol AR-50 | 1 pt. | | |
| BHC wettable powder | 0.25 lb. | | |
| 10% gamma isomer | Gamma isomer | | |
| Soya-flour | 1 lb. | | |
| Dormant oil | 1 gal. | Delayed dormant, Apr. 1 | 6.4 |
| Lime-sulphur | 3 gal. | | |
| Soya-flour | 1 lb. | | |
| Lime-sulphur | 10 gal. | Late balloon, Apr. 23 | 1.5 |
| Parathion, 15% wettable powder[3] | 7.5 lb. (per acre) | Late balloon, Apr. 23 | 0.6 |
| DDT, 50% wettable powder | 16 lb. (per acre) | Late balloon, Apr. 23 | 0.4 |
| Check | No spray | | 11.2 |

[1] Based on approximately 1,500 fruits taken at random from fifteen trees in each plot, with exception of parathion plot, where only 180 were examined.
[2] 38 S.S.U. Vis. 100° F., 75 per cent U.R. Shell Oil Company, Penticton, B.C.
[3] American Cyanamid Company, New York, N.Y.

**Table IV.—Injuries Caused to Peach-trees by the First-generation Larvæ of the Peach Twig Borer, and Injuries Caused to the Fruit by Second-generation Larvæ, after Various Delayed Dormant Sprays, 1948.**

| Material | Amount per 100 Gal. | Twigs Injured per 12 Trees | Fruit Injured[1] |
|---|---|---|---|
| | | | Per Cent |
| Distillate oil[2] | 1 gal. | 11 | 1.6 |
| Velsicol AR-50 | 1 pt. | | |
| BHC wettable powder | 0.25 lb. | | |
| 10% gamma isomer | Gamma isomer | | |
| Soya-flour | 1 lb. | | |
| Dormant oil | 1 gal. | 8 | 1.0 |
| Velsicol AR-50 | 1 pt. | | |
| BHC wettable powder | 0.25 lb. | | |
| 10% gamma isomer | Gamma isomer | | |
| Soya-flour | 1 lb. | | |
| Dormant oil | 1 gal. | 5 | 1.4 |
| Lime-sulphur | 3 gal. | | |
| Soya-flour | 1 lb. | | |
| Parathion, 15% wettable powder | 1 lb. | 5 | 4.2 |
| DDT, 50% wettable powder | 6 lb. | 7 | 0.6 |
| Check | No spray | 275 | 7.3 |

[1] Based on approximately 2,500 fruits taken at random from fifteen trees in each plot.
[2] 38 S.S.U. Vis. 100° F., 75 per cent U.R. Shell Oil Company, Penticton, B.C.

sequently, the most reliable method of estimating control is by counting the number of twigs injured by the first-generation larvæ. When the twigs are injured by other agents, such as peach leaf curl, it is usually impractical to separate the two types of twig injury; then it becomes necessary to use the percentage of fruit injured by second-generation larvæ as an estimate of control.

The use of DDT for the control of the peach twig borer in British Columbia orchards may not be so suspect as originally thought. Phytophagous mites have not increased to any noticeable degree on peach or apricot trees sprayed with DDT. Furthermore, the balloon-bud and petal-fall sprays of DDT probably do not affect the adults of *P. pyralidis,* because this parasite does not emerge from the mature borer larva until about one month after petal-fall of peaches.

## Summary

Balloon-bud or petal-fall sprays of DDT gave better control of the peach twig borer in British Columbia peach and apricot orchards than the usual balloon-bud spray of lime-sulphur, and did not cause any noticeable increase in numbers of phytophagous mites. Delayed dormant sprays of dormant oil-BHC, distillate oil-BHC, and dormant oil-lime-sulphur gave rather good control in three out of four orchards, but were not so effective as a balloon-bud spray of lime-sulphur. The oil-BHC sprays killed most of the larvæ before they emerged from hibernation, whereas the oil-lime-sulphur killed many larvæ after they emerged from hibernation. BHC was presumably largely responsible for the lethal effect of the oil-BHC mixtures, the oil acting mainly as a vehicle to bring the BHC into contact with the hibernaculæ. A delayed dormant spray of dormant oil-DNOC-soyaflour gave satisfactory control, but it injured apricot buds; without soya-flour emulsifier, the spray was very injurious to dormant peach-trees. Limited evidence indicated that a balloon-bud spray of parathion was most effective in controlling the borer. A balloon-bud spray of Systox was not quite so effective as a balloon-bud spray of lime-sulphur.

**Table V.—Injuries Caused to Peach-trees by the First-generation Larvæ of the Peach Twig Borer, and to the Fruit by Second-generation Larvæ, in Duplicate Plots after Various Balloon-bud and Petal-fall Sprays, 1952.**

| Material | Amount per Acre | Stage and Time of Application | Twigs Injured per Tree[1] Average | Fruit Injured[2] |
|---|---|---|---|---|
| | | | | Per Cent |
| DDT, 50% wettable powder | 16 lb. | Late balloon, Apr. 24 | 7.1 | 0.0 |
| DDT, 50% wettable powder | 16 lb. | 90% petal-fall, May 12 | 15.1 | 0.1 |
| Lime-sulphur | 20 gal. | Late balloon, Apr. 24 | 10.1 | 0.5 |
| Systox, 42.4% emulsifiable liquid[3] | 0.25 gal. | Late balloon, Apr. 24 | 17.9 | 1.3 |
| Check | No spray | | 35.7 | 16.7 |

[1] Based on approximately ten trees per plot, except that the single check plot was based on fifteen. Figures include twigs injured by the previous severe winter.

[2] Based on 1,000 fruits per plot, except that the single check plot was based on 180.

[3] Diethoxythiophosphoric acid ester of 2-ethyl mercapto-ethanol. Geary Chemical Corporation, New York, N.Y.

# NOMENCLATORIAL NOTES ON PLECOPTERA

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Since publication of my last stonefly paper, additional studies have indicated the new synonymies and placements described below.

### *Capnia labradora* n. sp.

1944. *Capnia columbiana* Ricker (in part), Canadian Ent. 76, p. 178. (Figs. 4, 7, and 11 illustrate the new species *labradora*.)

Holotype ♂ and paratype ♂: Nain, Labrador, July 2, Waugh. (Holotype in the Canadian National Collection, paratype in the author's collection.)

The two specimens above were described and illustrated in the 1944 paper. Their rather close resemblance to the western species *columbiana* suggested caution in proposing a new name, but additional western material shows that it does not vary toward the eastern type. The supra-anal processes of the two species are compared in Figs. 11 and 12 of the 1944 paper; in *columbiana* the tips are more divergent, and the hind border is wavy.

### *Capnia nearctica* Banks

1918. *Capnia nearctica* Banks, Rep. Can. Arctic Exped.; 3(B), p. 3.

1938. *Capnia hantzschi* Ricker, Can. Ent. 70, p. 173. *New synonymy.*

1944. *Capnia nearctica* Ricker, Can. Ent. 76, p. 178.

Study of a paratype of *nearctica* at the Museum of Comparative Zoology, now mounted in balsam, shows that it agrees completely with the descriptions of *hantzschi* given by me in 1938 and 1944. The holotype of *nearctica* is supposed to be at Ottawa, but apparently cannot be found there; however, all of the type series were from the one locality.

### *Nemoura (Podmosta) decepta* Frison

1942. *Nemoura decepta* Frison, Pan-Pac. Ent., 18, p. 13. Description of ♂.

1943. *Nemoura decepta* Ricker, Indiana Univ. Pub., Sci. Ser. 12, p. 69. Description of ♀ from teneral specimens.

1952. *Nemoura rossi* Ricker, Indiana Univ. Pub., Sci. Ser. 18, p. 45. Description of ♀. *New synonymy.*

Collections of *decepta* containing mature individuals of both sexes have now been received from Mr. R. A. Hays and Mr. S. G. Jewett, Jr. They indicate that the females described as *rossi* belong with *decepta*. My 1943 illustration (Fig. 37) of the female is inadequate. More extensive dusky pigment along the cord of the wing distinguishes fully-hardened specimens of this species from *delicatula,* but this difference is better shown in the female than in the male.

### *Leuctra (Despaxia) augusta* Banks

1907. *Leuctra augustus* Banks, Can. Ent. 39, p. 330. Description of ♀.

1923. *Leuctra glabra* Claassen, Can. Ent. 55, p. 261. Description of ♂. *New synonymy.*

1925. *Leuctra augusta* Needham and Claassen, Monogr. Plecop., p. 224. (The female illustrated was evidently drawn from the type, but is very misleading.)

1925. *Leuctra glabra* Needham and Claassen, Monogr. Plecop., p. 228.

1929. *Leuctra glabra* Neave, Contr. Can. Biol. Fish. 4, p. 162. Description of ♀.

1952. *Leuctra glabra* Ricker, Indiana Univ. Pub., Sci. Ser. 13, p. 78. New illustrations of ♀.

There are two cotypes of *augusta* in the MCZ (not just one, as stated in 1952), and one of them is complete. The reduction of abdominal sclerotization and the form of the subgenital plate are as in *glabra*.

### *Leuctra (Paraleuctra) occidentalis* Banks

1907. *Leuctra occidentalis* Banks, Can. Ent. 39, p. 239. The type series includes specimens of *occidentalis, purcellana* Neave, and *forcipata* Frison.

1923. *Leuctra bradleyi* Claassen, Can. Ent. 55, p. 257. *New synonymy.*

1925. *Leuctra bradleyi* Needham and Claassen, Monogr. Plecop., p. 225; also later authors.

1942. *Leuctra projecta* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 260. *New synonymy.*

1952. *Leuctra occidentalis* Ricker (in part), Indiana Univ. Pub., Sci. Ser. 18, p. 172. Designated ♀ specimen No. 11370 in the MCZ as lectotype (but identified it wrongly).

1952. *Leuctra augusta* Ricker, *ibid.*, p. 172. (Not *augustus* Banks, 1907.)

The selection of the MCZ ♀ in 1952 as lectotype was made " to conserve current usage," in the belief that the specimen was the same as the *occidentalis* of Needham and Claassen and later authors. Unfortunately, new study of this type specimen shows that conservation of present usage is impossible, since its subgenital plate is characteristic of *bradleyi* Claassen rather than *occidentalis* auctores.

The species *occidentalis* (*bradleyi*) is quite variable in respect to the size and shape of the subterminal spine of the male cercus. The holotype of Frison's projecta has it truncated, although the paratype illustrated by him is slender and more typical. Even greater variation than shown by Frison occurs between different streams within a restricted area, and there seems no basis for the recognition of *projecta.*

### *Leuctra (Paraleuctra) sara* Claassen

1925. *Leuctra occidentalis* Needham and Claassen, Monogr. Plecop., p. 231; and most subsequent authors. (Not *occidentalis* Banks, 1907.)

1937. *Leuctra sara* Claassen, J. Kansas Ent. Soc. 10(2), p. 44.

1952. *Leuctra occidentalis* Ricker (in part), Indiana Univ. Pub., Sci. Ser. 18, p. 122. (All records except the lectotype are *sara.*)

Authors generally since 1925 have followed Needham and Claassen in their erroneous application of the name *occidentalis* to this commonest western species of *Paraleuctra*. Claassen's *sara,* described from New York and widespread in the East, cannot be distinguished from the western form, although there is much variation in the cerci of both (cf. Frison, 1942, Bull. Illinois Nat. Hist. Survey, 22, p. 259).

The four species to be recognized in *Paraleuctra* are *forcipata* Frison, *occidentalis* Banks, *purcellana* Neave, and *sara* Claassen.

The synonymy of western *Leuctra* is summarized below:—

*augusta* Banks (*glabra* Claassen and *auct.*)

*forcipata* Frison

*infuscata* Claassen

*occidentalis* Banks (*bradleyi* Claassen and *auct.; projecta* Frison; *augusta* Ricker 1952, not Banks)

*purcellana* Neave (*bilobata* Claassen).

*sara* Claassen (*occidentalis auct.,* not Banks).

### *Isoperla petersoni* Needham and Christenson

1927. *Isoperla petersoni* Needham and Christenson, Utah Agr. Exp. Sta. Bull. 201, p. 19. (This publication contains the first mention of this name, and illustrations of both nymph and adult of the insect it applies to, which must be regarded as "indications" in the sense of the International Rules. The name has subsequently been ascribed to both "Claassen" and "Needham.")

1929. *Isoperla fontium* Neave, Contr. Canadian Biol. Fish., 4, p. 161. *New synonymy.*

1931. *Isoperla petersoni* Claassen, Plecop. Nymphs N. Am., p. 74. Description of nymph.

1937. *Isoperla petersoni* Needham; in Claassen, Can. Ent. 69, p. 81. Description of ♂ ♀.

The penial sclerite and body markings of *fontium* agree with *petersoni*. The short wings of the type series of *petersoni* are exceptional but not unique; they apparently mark an isolated southern population of this species, which is abundant in the Canadian cordillera. However, similar short-winged populations of other stoneflies do not receive taxonomic recognition, and intergradations are common.

### *Alloperla severa* (Hagen)

1861. *Perla severa* Hagen, Syn. Neur. N. Amer., p. 30. Island of Unga, Russian America.

1937. *Alloperla elevata* Frison, Trans. Amer. Ent. Soc. 61, p. 335. *New synonymy.*

1952. *Alloperla thalia* Ricker, Indiana Univ. Pub., Sci. Ser. 18, p. 178. *New synonymy.*

The absence of dark markings on the meso- and meta-thorax of the holotype of *severa* mark it as one of the typical subgenus of *Alloperla*. The "narrow brown stripe" on the pronotum, noted by Hagen, is evidently not epidermal pigment but discoloration from below, in drying. The abdomen of the specimen is missing, but its fairly large size (13 mm. to wing tips) identifies it with *elevata* Frison, which is very common along the Pacific Coast of North America and has been taken west to the Matanuska Valley of Alaska. Other western *Alloperlæ* (s.s.) are smaller, and also much scarcer.

The species *thalia* was described from two Montana males in which the supra-anal process was straight-sided, rather than dumbell-shaped, as is typical in *elevata*. However, additional material from the type locality shows that straight and dumbell shapes intergrade, and even coastal specimens vary somewhat in this respect. The female subgenital plate, described as rounded in *thalia* and subacute in *elevata,* also varies between these forms within single populations. Thus the Montana specimens are evidently an Interior form of *severa* (*elevata*), rather smaller than the Coast form and possibly differing in other average characters, but scarcely worth taxonomic recognition.

### *Calineuria* new subgenus

This is proposed as a subgenus of *Acroneuria* Pictet, with type species *A. californica* Banks. The other known species is *A. theodora* Needham and Claassen. It is distinguished by the elongate-rectangular (rather than transversely-oval) hammer on the ninth sternite, and by the presence of a fairly complete transverse row of spinules across the occiput of the nymph, which, however, is not completely regular and is interrupted at the midline. Subanal gill tufts are absent. Both species are from the cordillera.

### *Attaneuria* new subgenus

Another subgenus of *Acroneuria,* this is proposed for the single Eastern American species *A. ruralis* Hagen. It is characterized by a complete, though somewhat wavy, row of transverse spinules across the occiput of the nymph, a transversely-oval hammer on the ninth sternite of the male, and absence of subanal gill tufts. *Acroneuria* nymphs other than *Calineuria, Attaneuria,* and *Hesperoperla* all lack the transverse row of spinules on the occiput, though they have a few scattered bristles near the eyes.

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART I—LASIOCAMPIDÆ, SATURNIIDÆ, LIPARIDÆ*

D. A. ROSS† AND D. EVANS‡

## Introduction

This is the first of a series of annotated lists of insects collected or reared by personnel of the Forest Insect Survey in British Columbia since 1937. For the most part, the insect species to be considered are feeders on forest trees, although insects of shrub-sized *Alnus* spp., *Salix* spp., and *Prunus* spp., etc., are also included. Families or genera of insects for which our data are most complete will be treated first.

Precise collection localities are noted only where there are less than five scattered locality records for a given species; otherwise, broad distribution categories are used. Categories employed herein are as follows: Vancouver Island; Coast (west of the Coast Mountain Range); Interior British Columbia (east of the Coast Range); Southern, Northern, and Central British Columbia. For convenience, " Southern B.C." refers to that section of the Province south of 52° latitude, exclusive of Vancouver Island; " Northern " refers to the area north of 57° latitude; and " Central B.C." is that portion between. Little survey work has been done in Northern B.C.; when the term " Northern B.C." is used, it refers to areas close to the Alaska Highway.

Brief descriptions, generally of full-grown larvæ, are included in the annotated list where such stages are known to one or both of the writers. The descriptions are by no means complete but in most cases should be adequate for specific determination.

## Lasiocampidæ

The caterpillars of this family are leaf-eaters. Species in the genus *Malacosoma*, the tent caterpillars, frequently are spectacular defoliators, denuding the trees or shrubs over extensive areas. Common characters of the lasiocampid larvæ are: Head dull, i.e., not glossy; head and body covered with simple hairs, the hairs not in discrete tufts; body smooth. The larvæ spin cocoons on the host or adjacent trees. Overwinter in egg stage.

***Tolype dayi*** Blkm. *Pseudotsuga taxifolia, Tsuga heterophylla*; Vancouver Island. LARVA: 1½ inches; wide and flattened, flecked in pastel shades of brown and grey, light subdorsal and supraspiracular patches; subspiracular lappets with clumps of long fine hair, hair shorter and less dense on remainder of body; humped tubercles on subdorsum of each segment, largest on T3 and A8; transverse orange fold on dorsum of T3; venter pinkish with dark blotches shaded to orange.

***Tolype laricis*** Fitch. *Larix occidentalis,* Vernon; *Pseudotsuga taxifolia,* Barriere.

***Malacosoma pluviale*** (Dyar). Western tent caterpillar. *Prunus,* spp., *Alnus* spp., *Salix* spp., *Amelanchier* spp., *Malus* spp., *Rosa* spp., and other shrubby growth; Southern B.C. and Vancouver Island. Caterpillars form large, unsightly communal tents of silk over the branches adjacent to the leaves on which they are feeding. Eggs laid on twigs of host plant, close to the ground; cemented in a curved mass, seldom forming a complete band about the twig. LARVA: 1¾ inches; head greyish, speckled with black; body blackish; broken, greyish-blue middorsal stripe; orange blotches along addorsal area; greyish-blue blotches on subdorsum; orange, wavy supraspiracular stripe; subspiracular area, orange; hairs orange.

***Malacosoma pluviale*** (Dyar) var.? So far as is known, the geographical ranges of this and the preceding form are separate.

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Limited to *Betula glandulosa* and *Salix* spp. bordering swamps and muskegs; Central Interior B.C., 1947—defoliated scrub birch at Aleza Lake; 1950—larvæ abundant near Stone Creek, Cluculz Lake, Wells, and north-east of Isle Pierre; 1951—caused light defoliation at various points in the Prince George area. This species makes communal silken tents similar to *M. pluviale*. Eggs in cylindrical mass about twig, similar to *M. disstria*. The larvæ frequently form communal cocoons; as many as six pupæ are enclosed in a single envelope. LARVA: 1¾ inches; basic markings similar to *M. pluviale,* but very little orange coloration (replaced by black) in most specimens.

***Malacosoma disstria*** Hbn. Forest tent caterpillar. *Populus tremuloides, Populus trichocarpa, Alnus* spp., *Salix* spp., *Betula papyrifera,* and other broad-leaved trees and shrubs; during heavy outbreaks may spread to and damage new growth of conifers; generally distributed. Medium to heavy infestations have been reported at one or more localities in British Columbia during the following periods: 1938, 1941–43, 1945–47, 1949–53. Apparently the most recent of these outbreaks is the largest and most widespread of those occurring during the past fifteen years. No tree mortality has been reported following any of these infestations. The depredations of this species cause considerable concern to tourist-camp operators and home-owners with dwellings within or adjacent to poplar stands. Eggs cemented together in a cylindrical mass about a twig, usually in upper crown of the tree. No tents formed. LARVA: 2 inches; head and body, pale greyish-blue, speckled with black; black-bordered orange subdorsal and supraspiracular stripes; additional orange and black line-markings on dorsum; off-white or cream-coloured blotches along middorsum.

***Epicnaptera americana*** Harr. Lappet moth. *Populus tremuloides, Populus trichocarpa, Quercus* spp., *Salix* spp., *Betula papyrifera, Alnus* spp., *Amelanchier* spp., *Acer* spp., *Corylus* spp., *Cratægus* spp., *Malus* spp.; generally distributed; not recorded in outbreak proportions. LARVA: 2 inches; head and body, hairy; flap-like projections beneath the spiracular area; body greyish, finely speckled with black, some orange spots; two reddish or orange black-edged transverse bands on dorsum of thorax (bands concealed when body contracted); middorsal protuberance on A8; venter flattened, orange with black blotches.

### Saturniidæ

The silk moths are relatively unimportant defoliators in this Province. Their large size and the striking coloration of some species attracts much attention from the general public. The larvæ have spine-bearing tubercles or dense groups of spines and branched spines on the thorax and abdomen.

***Hyalophora euryalus*** (Bdv.). Ceanothus silk moth, incorrectly called "Cecropia." *Ceanothus sanguineus, Alnus* sp., *Salix* spp., *Ribes* spp., *Betula* spp., and other deciduous hosts; Southern Interior, Victoria, Saltspring Island, Quesnel. Cocoon, pointed at one end, firmly attached to twig on host tree; overwinters. LARVA: 3¼ inches, stout; head and body, yellowish-green; elongate tubercles, each tipped with small black spines; subdorsal and lone middorsal (A8) tubercles red, those on the meso- (T2) and meta-thorax (T3), and middorsum of A8 ringed with black; tubercles in supra- and sub-spiracular rows, white and bluish, black at bases.

***Autheræa polyphemus*** (Cram.). Polyphemus. *Betula papyrifera, Quercus garryana, Alnus* sp., *Prunus* sp., *Salix* spp., *Populus tremuloides;* Vancouver Island, Southern and Central Interior B.C. Cocoon broadly rounded at both ends, usually formed within leaves; as a rule winters on the host tree suspended on the twigs or the trunk. LARVA: About 3 inches; head yellowish-brown; body green; row of elongate tubercles, with pale bristles along subdorsal, supra- and sub-spiracular areas; all tubercles, except the yellow anterior subdorsal pair, are an orange-red, those above the spiracles with silvery bases; almost vertical cream-coloured line behind red spiracles on A1 to A8; suranal plate edged laterally with purple and white. Larva takes hunched stance when at rest.

***Pseudohazis eglanterina*** Bdv. Range moth. *Salix* spp., *Populus tremuloides, Amelanchier* spp., *Spiræa* spp.; Vancouver Island, Silver Creek, Rock Creek, Vernon. Probably has two-year cycle; overwinters in cocoon or in egg stage. Eggs in mass about twigs. LARVA: 2¼ inches; head, brown, hairy; body, dark brown, paler intersegmental areas; rather obscure, off-white, subdorsal, supra- and sub-spiracular and midventral stripes; row of dense clumps of brown spines along subdorsum; rows of dark-brown branched spines along supra- and sub-spiracular areas; portions of body clothed with fine grey hair.

### Liparidæ

Members of this family are defoliators of coniferous and deciduous trees. The caterpillars are hairy, and all but *Stilpnotia* have prominent tufts of plumose hairs. Liparids may be distinguished from the larvæ of other families by the eversible glands (bright red on *Hemerocampa* and *Notolophus*) on the middorsum of abdominal segments 6 and 7. Pupation occurs within thin grey or whitish silken cocoons spun on the leaves, branches, or trunks of the host or adjacent trees. Wings of female *Notolophus* and *Hemerocampa* are rudimentary.

***Notolophus antiquus*** (L.). Rusty tussock moth. *Alnus* spp., *Salix* spp., *Betula papyrifera, Acer* sp., *Malus* spp., *Tsuga heterophylla, Pseudotsuga taxifolia, Picea engelmanni, Picea sitchensis, Larix occidentalis, Abies lasiocarpa, Abies grandis, Thuja plicata* (two records), *Pinus contorta* (two records); generally distributed; occasionally numerous. Overwinters in egg stage. LARVA: 1 inch; head, glossy black; dorsum of body, grey with black dorsal stripe, narrow on thorax, broad on abdomen (body may be almost entirely blackish); orange tubercles; brush-like tufts of cream or buff-coloured hair on segments A1 to A4 (in early instars, the first two tufts are black, last two are pale); a long pencil of black plumose hairs on A8, and similar lateral pencils on T1; females have an additional lateral pencil-tuft on A2.

***Hemerocampa pseudotsugata*** McD. Douglas-fir tussock moth. *Pseudotsuga taxifolia;* this species may spread to other coniferous hosts during an infestation. Southern Interior. Outbreaks in the Southern Interior occurred during the following periods: 1918–22, 1928–31, 1938–39, and 1946–49. In most infestations heavy defoliation on a given area apparently was limited to one or two years. Overwinters in egg stage. LARVA: 1¼ inches; head, glossy black; body, hairy, grey and black with broken orange-yellow subspiracular stripe; red tubercles; two prominent black lateral pencil-tufts on T1 and one black dorsal pencil-tuft preceded by a shorter recurved rust-coloured tuft on A8; a dense rust-tipped brush-like tuft on dorsum of each segment A1 to A4; venter pale. Contact with the larval hairs of this species causes a skin rash on some persons.

***Parorgyia styx*** (B. & McD.). *Tsuga heterophylla, Pinus monticola* (two records); Coastal B.C. and Vancouver Island. *Parorgyia* spp. have a two- or three-year cycle. LARVA: 1½ inches; dark brown; prominent brush-like clumps of mole-grey hair on dorsum of A1 to A4; very long pencil-tufts of dark clubbed setæ on subdorsum of T1 and A9, single tuft on dorsum of A8; balance of dorsum with tufts of long yellowish setæ, more dense subdorsally on T3 and A5; interspersed with longer clubbed dark setæ subspiracularly.

***Parorgyia grisefacta*** (Dyar). *Pseudotsuga taxifolia, Tsuga heterophylla, Picea engelmanni, Picea glauca, Abies lasiocarpa, Larix occidentalis, Pinus contorta;* Interior B.C.; no infestations recorded. Overwinters in the larval stage.

LARVA: 1¾ inches; head, dark brown; dorsum of T1 and A5 to A10 rusty-brown; sides of body, occasionally whole body, blackish; a long black pencil-tuft on the dorsum of A8 and similar lateral paired pencil-tufts on T1 and A9; shorter tufts of plumed black hairs along the supra- and sub-spiracular areas; dirty white brush-like tufts on dorsum of segments A1 to A4; numerous short, white plumed hairs in most of the setal tufts on body above spiracles.

***Stilpnotia salicis*** (L.). Satin moth. *Populus tremuloides, Populus trichocarpa, Salix* spp. (*Populus nigra* and *P. alba*—exotic species). An introduced insect, first discovered at New Westminster during 1920; spread to Vancouver Island by 1932, and up the Fraser River as far as Clinton and east along Thompson River Valley to Bestwick by 1953. During 1944 and 1945, cottonwoods at Botanie Valley, near Lytton, were defoliated; in 1946 a light infestation was observed at a point 10 miles south of Clinton. During 1949, defoliation occurred in several new localities—Savona, Ashcroft, and Stump Lake in the Nicola Valley. Overwinters as young larva in hibernaculum. LARVA: About 2 inches; head, dull black; body, blackish, with a row of constricted white blotches on the dorsum; broken, white subdorsal line; prominent reddish-brown tubercles bearing clumps of brownish hairs on upper portions of the body.

**Reference**

Jones, J. R. J. L. An annotated check list of the macrolepidoptera of British Columbia. Occasional Paper No. 1, Ent. Soc. B.C. 148 pp. 1951.

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART II—*LASPEYRESIA* SPP. (OLETHREUTIDÆ)*

D. A. Ross†

Some species of *Laspeyresia* are economically important cone - borers and seed-feeders, others are bark-miners of undetermined economic significance. Few adults of the latter group have been reared during the course of Forest Insect Survey investigations in British Columbia.

Characters common to full-grown *Laspeyresia* larvæ in the following list are: Length, two-fifths to three-fifths of an inch; head brownish, partially retracted into the thorax; body, pale cream-coloured or whitish; body setæ minute; ventral proleg crochets in complete oval or ellipse; thoracic legs small.

***L. bracteatana*** (Fern.). *Picea sitchensis* cones, Queen Charlotte Islands. Heinrich saw the specimens that established this record and stated that they were best placed as *bracteatana*.

***L. rana*** Forbes. One specimen in Vernon reference collection, B.C. Survey No. 41-3082, with no data. This species mines bark of *Picea engelmanni*. (Heinrich 1926.)

***L. youngana*** (Kearf.). *Picea glauca* cones; Central and Northern Interior; Whitehorse, Carcross, Yukon Territory. Occurred in infestation proportions in several areas during 1952 and 1953. Larva bores through scales, seeds, and rachis of cone; overwinters in cone, and pupates in spring. LARVA: Three-eighths of an inch long; pale cream-coloured.

***L. piperana*** (Kearf.). *Pinus ponderosa* cones, Grand Forks.

***L. miscitata*** Hein. *Pinus ponderosa* cones; Southern Interior. Apparently this species is much commoner than *piperana,* which it resembles very closely in appearance and habits. The larvæ burrow through the scales and seeds; often feeding does not prevent the complete opening of mature cones.

About 80 per cent of the cones on some trees sampled in the Kamloops Forest District were infested each year during the period 1950 to 1953. From one to six late-instar larvæ have been found in individual cones. Larvæ overwinter in the rachis of the cone and pupate in the spring. LARVA: Three-fifths of an inch long.

***Laspeyresia*** spp. Two species (one noted by Walters 1953) other than those listed above, mine *Pinus monticola* bark in Southern B.C. One has been determined as *L.* sp. probably *obnisa* Hein. The other species is close to *piperana*.

## Acknowledgment

The writer is indebted to Dr. T. N. Freeman for identifying most of our specimens in the genus *Laspeyresia*.

* Contribution No. 161, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

† Forest Biology Laboratory, Vernon, B.C.

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Heinrich, C. Revision of the North American moths of the subfamilies Laspeyresiinæ and Olethreutinæ. U.S.N.M. Bull. 132. 1926.

Walters, J. *Laspeyresia* sp. as a bark moth on western white pine. Can. Dept. Agr., For. Biol. Div., Bi-monthly Prog. Rept. 9:4. 1953.

# SEXING AND RECLAIMING DRIED SPECIMENS OF *DENDROCTONUS ENGELMANNI* HOPK.*

M. G. Thomson
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Two techniques which may not be widely known were recently brought to the attention of the writer. One, which does not destroy the living beetles or specimens, is a rapid method for determining the sex of adults of some species of *Dendroctonus.* The other is a method for reclaiming dried or pinned specimens for histological study. The use of these techniques on adults of *Dendroctonus engelmanni* Hopk. is reported in this paper.

Several years ago it was necessary to determine the sex of a number of Engelmann spruce beetle adults. At that time a description of the external characteristics which satisfactorily separated the sexes could not be located, and it was necessary to dissect the specimens. The presence or absence of the dark-brown forked spicule of the male provided the most rapid method of confirming the sex.

Recently, Mr. V. McCowan, entomologist for Weyerhæuser Timber Company, was able by touch to determine accurately the sex of over 400 adults of *Dendroctonus pseudotsugæ* Hopk. This technique can be used successfully with *D. engelmanni.* To establish the point, a collection was used of 105 specimens from Bolean Lake, pinned in 1950. These specimens were examined first by touch, then externally under the microscope, and, finally, internally.

Irregularly scattered over the interstrial spaces of the elytral declivity of the female are a number of tubercules. These are most numerous adjacent to the elytral suture and can be felt readily. The tubercules were rarely present on the elytral declivity of the male.

To determine the sex of a specimen, a finger is run backward and downward over the caudal portion of the elytra so that the feel of the tubercules is not confused with that of the hairs and bristles. The elytral declivity of the female feels like fine emery paper, whereas that of the male feels like talc.

After determining the sex of each specimen as described above, the presence of tubercules was noted. The sex was confirmed by dissection. Sixty-eight of the specimens were female. Two of the specimens were incorrectly sexed by touch; both were males and both had prominent tubercules.

Before dissection, the specimens were first soaked for two hours in a 0.5-per-cent solution of tri-sodium phosphate. The writer is indebted to Dr. J. A. Chapman for drawing his attention to this technique of van Cleave and Ross for reclaiming dried specimens for histological purposes. These authors report that the solution restores the normal appearance of small invertebrates, making them relatively soft and pliable without showing any dissociation of tissue. This was borne out in the present investigation. After treatment it was possible to examine the gut for food content, to determine the number of eggs present, and to identify the various reproductive structures. The tissues were pliable but not fragile.

One of the interesting sidelights of the examination was the discovery of nematodes in a large number of the specimens. Where present they were usually very numerous and densely packed ventrally in the abdominal cavity and in the vicinity of the proctodæum. The adults of 43 per cent of the seventy-five galleries represented by the collection were infested.

* Contribution No. 139, Division of Forest Biology, Science Service, Department of Agriculture, Ottawa, Canada.

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# GRASSHOPPER POPULATION SAMPLING*†

R. H. Handford‡

Further illustration of the sampling principles discussed by Graham and Stark (1954) may be taken from problems encountered and methods used in sampling grasshopper populations. Unfortunately, many of the available examples are *still* problems, and manv of the methods in practical use have not been critically tested for suitability and adequacy. The author has drawn from his own experience and from published accounts only sufficient material to illustrate the principles involved and to provide a reasonablv comprehensive description of methods.

## Purposes of Sampling Different Stages

The annual grasshopper survey is one of the most extensive projects in Canada and the United States requiring the use of specific sampling methods and techniques; the maps prepared from the survey data have proved to be of immense practical value to officials responsible for conducting control campaigns.

The maps are based on the numbers of eggs found in soil units of one square foot each, classified in terms of damage that might be expected during the following spring and summer; their accuracy in this respect varies with weather and crop conditions. The egg stage is used, rather than the adult stage, not only because it is "more stationary" and lends itself to "standard statistical procedures" (Graham and Stark, 1954) but also because adults can, and sometimes do, migrate from one area to another after an estimate has been made of their numbers and before egg-laying has been completed. Moreover, the number of eggs laid under various combinations of conditions by a given number of females has not been accurately determined. However, estimates of adult grasshopper populations are made before surveys of egg deposits in order (1) to provide rough indications of the area that may be omitted from the egg survey and (2) to provide data that can be used where necessary to supplement data obtained from the egg survey. The latter use is particularly important when autumn rains make completion of egg surveys impossible. Estimates of nymphal populations are made in restricted, representative areas to indicate the accuracy of the preceding egg survey.

Estimates of egg and nymphal populations are also required in experiments on control by means of cultural practices; estimates of nymphal and adult populations are required in experiments on chemical and biological control; and estimates of populations of all three stages are used in studies of population dynamics and the effects of ecological factors.

## Methods of Sampling Different Stages and Species

*Melanoplus mexicanus mexicanus* (Sauss.), being the most widespread, persistent and generally injurious species in North America, has been the one most commonly used in studies of sampling methods. Probably the fact that it is more uniformly distributed than the other pest species, and more amenable to statistical procedures, has also influenced workers in this field.

### Eggs of *Melanoplus m. mexicanus*

In sampling for eggs of *M. m. mexicanus* in the prairies of Western Canada, it is standard practice to sift samples of soil through a six-mesh screen, watching for eggs and egg pods in the soil as they fall through the screen, and finally for those left on the screen itself. Five sample units of one square foot, or ten of one-half square foot each, are taken per field. The units are distributed, without selection, over a distance of about 100 yards, but not necessarily at random.

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† Editor's Note: This paper, which was read at the Kelowna meeting of the Ent. Soc., B.C., March, 1954, as part of a symposium on population sampling methods, reached the Editor just too late for inclusion in Vol. 51 of the Proceedings with that of Graham and Stark (1954).—K.M.K.

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Routes of travel are adjusted to average about one field in one and one-half townships. Most of the samples are taken in grain fields, but if roadsides are in suitable condition for oviposition by this species they are also sampled.

Davis and Wadley (1949) found that sparse populations of eggs of *M. m. mexicanus* in the Great Plains area of the United States came very close to the Poisson, or truly random, distribution; as populations increased in density the variance increased more rapidly than the mean, indicating a departure from the Poisson series in those categories. However, they went on to explain that analyzing the data "as if the fields had been taken at random . . . does not lead to serious mistakes . . . What inaccuracy there is will be on the conservative side."

Considering practical as well as theoretical aspects, Davis and Wadley decided that sample units within fields need not be taken according to a fixed pattern nor by a strictly random method, but they should extend well into the field and be free from personal choice; fields to be sampled should be selected by systematic (stratified) methods. Allowing an error of 0.125 of a pod per square foot, they found that five square feet in each of ten fields would be sufficient for a county, or group of similar counties, containing uniform populations in the lower categories. Denser and/or less uniform populations could be brought within the limits of accuracy more economically by increasing the number of fields rather than the number of sample units within fields; 30 fields was the maximum number per county or group of similar counties required for any of the conditions studied by Davis and Wadley.

On the basis of these conclusions, more than 30 fields in 3000 square miles would rarely be required in a practical survey of eggs of *M. m. mexicanus* over large areas of country; considerably fewer than 30 would have to be sampled under conditions more commonly encountered. This suggests that Canadian surveys of the same species at the rate of five square feet in each of five or six fields per 324 square miles (nine townships) should be highly accurate in the main, the accuracy increasing directly with the size of an infested area and inversely with the intensity of infestation.

**Eggs of** ***Camnula pellucida***

The methods used to sample nymphal and adult populations of *M. m. mexicanus* differ greatly from those used to sample egg populations of that species, and the methods used to sample egg populations of *Camula pellucida* (Scudd.) also differ from those used to sample egg populations of *M. m. mexicanus*. These differences serve as excellent illustrations of the truth of the statement that "the sampling of a particular insect population must be resolved about the distribution and life cycle of the insect involved" (Graham and Stark, 1954).

Egg deposits of *C. pellucida* tend to be concentrated in restricted areas of sod of relatively few species of grass. To obtain an accurate estimate of such a variable population by strictly random means is impractical in general surveys (King, 1939). An attempt is made, therefore, to estimate the size and number of egg beds in a given number of miles of roadside or pasture, doing just enough detailed sampling to obtain a reasonably accurate estimate of the classes, or categories, into which the egg beds fall. Unlike the oviposition sites of *M. m. mexicanus,* the sod in the favoured sites of *C. pellucida* is usually too tough to make soil sifting possible; it must be shaved with a sharpened trowel or lifted with a spade, placed in a screen, and teased apart by hand. Where populations fall into the same category over a considerable area it may be possible to make as few as three stops in two townships, but in irregular infestations, or those lying close to the boundaries of a category, an observer may be obliged to make up to six stops per township. It is doubtful whether the data obtained by these methods are amenable to standard statistical procedures; at best, considerable experience is required to interpret the results satisfactorily in terms of requirements for control.

#### Nymphs and Adults

Nymphal and adult populations are sampled by various methods, depending upon the use that is to be made of the resulting data and the accuracy required. During the annual survey, where it is desired to know the population per unit area but where economy of time is a major consideration, observers attempt to count the numbers of grasshoppers that leap or fly from quadrats of one square yard, the size of the quadrat being estimated visually. This is more difficult in nymphal populations because nymphs are less easily seen than adults and are usually present in much larger numbers per quadrat. The number of quadrats per field is not usually specified; an observer is required only to satisfy himself that he has obtained a reasonably accurate measure of the mean for the field. He rarely takes fewer than 10 quadrats or more than 25. The number of fields per municipality (Canada) or county (United States) closely approximates the number sampled during the egg survey. In experiments on chemical control, where it is necessary to know relative population densities only, comparisons are sometimes based on the number of specimens collected in a given number of strokes of a sweepnet (Hinman and Cowan, 1947). Smith and Stewart (1946), studying grasshopper populations in relation to biological control, developed a cage method that proved highly satisfactory for sampling nymphs and adults. These methods are all being compared at present with a method involving the dilution of a population with radio-active specimens. The work is being done under the leadership of L. G. Putnam, Grasshopper Research Co-ordinator for Canada, Entomology Laboratory, Saskatoon, Sask., and F. T. Cowan, Officer-in-Charge, United States Department of Agriculture, Agricultural Research Service, Entomology Research Branch, Bozeman, Mont.; the results have not yet been published.

## Effects of Undesirable Variables

The subjects "patterns of variability within a sampling universe" and the desirability of sometimes "sampling with respect to the known environmental variates" have been covered by Graham and Stark (1954). Where sampling is done to compare population levels under different sets of conditions (much sampling is done for this purpose), undesirable variables must be carefully noted, and removed if at all possible. For example, estimates of adult grasshopper populations in an adequate series of weedy grain fields might logically be compared with estimates in an adequate series of clean fields, providing one wishes to gain some information on the relative attractiveness of the two types of fields to the species concerned; but a comparison of the data would be of little value, probably quite misleading, if the estimates in the series of weedy fields were made on a clear, hot, dry, calm day by observer A and those in the clean fields on a cloudy, cold, wet, windy day by observer B. The example is obviously extreme, but most workers are guilty at times of overlooking or ignoring one or more variables that might seriously affect the reliability of their samples.

#### Vegetation

Examples of the effects of the variations in vegetation density are available in reports on experiments with poisoned baits: The mean percentage mortality in baited cages placed in relatively dense vegetation was 21.1 per cent lower than in an adjacent series in which the same crop had been artificially thinned; the difference necessary for significance at the five per cent level was only seven per cent (Handford, 1941). In two sets of experiments designed for other purposes, but differing in several factors including density of vegetation, the treatments in dense vegetation gave an average of 23.2 per cent mortality whereas those in sparse vegetation gave an average of 87.7 per cent (Handford and Putnam, 1942.) These are, of course, merely illustrations of the effects of variations in density of vegetation; in practice every effort is made to find uniform stands of vegetation for experiments in which treatments are being compared.

#### Weather

York and Prescott (1951), after making direct comparisons of sweep-net and cage methods of collecting grasshoppers at different times of the day and under different conditions, concluded that "the sweep-net method of sampling shows great variation in the catch of grasshopper nymphs and many other insects due to time of day and meteorological conditions, thus making it of little value in population studies. Its use in evaluating control on field plots seems valid if the treated and comparable untreated plots are sampled within a short period of time.

"Sampling with a cage is at least as fast as with the net, but is more 'back breaking'. It shows less variation from meteorological conditions than the insect net, and as a consequence is probably more advantageous when the weather is unfavorable for sweeping."

#### Personnel

That important differences can occur in the results obtained by different workers under almost identical conditions may be illustrated by a third example: Methods used in comparing the effects of different grasshopper baits on nymphs, described by Hinman (1939), required that a number of nymphs be collected from each plot and held in cages for 72 hours before mortality was determined. It was frequently necessary to have the collections made by two or three men in order to keep within uniform time limits. Using Student's *t* test on differences between pairs (Goulden, 1929), Handford and Putnam (unpublished report for the year 1940, on file at the Entomology Laboratory, Kamloops, B.C.) found that mean mortality difference of 12 per cent, in collections made by different workers, were significant at the 2 per cent level. The obvious correction was to have the collectors work as a group, each making part of the collection from each plot.

#### Removing Effects of Undesirable Variables

Where it is impractical or impossible to eliminate undesirable variables, every effort should be made to design techniques that will remove their effects. The six-mesh screen, for example, samples eggs of *M. m. mexicanus* satisfactorily under most conditions. However, where soil is gravelly, or moist, or full of debris, better results are obtained by using a four-mesh screen either alone or nested in the six-mesh screen. If soil is too moist to be handled this way, a good quality plasterer's trowel, well sharpened on the edges, serves to cut away thin layers of soil and expose the eggs. Soil that is baked can be cracked by means of a wooden mallet or block; if eggs are present the lumps usually break along the course followed by the ovipositor, thus exposing the pod.

### Bias Resulting from Personal Selection

That "personal selection" may easily "bias the estimation of the mean" (Graham and Stark, 1954) may be illustrated by work done on sampling grasshopper egg populations. The author, in sampling fields at Piapot, Sask., in 1943, obtained a mean of 1.03 pods of *M. m. mexicanus* and *M. packardii* Scudd. per square foot in non-selected, stratified sampling, and a mean of 2.5 pods per square foot for selected, stratified samples; the difference, analyzed by Student's *t* test on differences between pairs, was significant at the 1 per cent level. The only criterion for selection was that the area from which a sample was taken should have been subjected to the maximum effects of the sun's rays; each selected sampling point was limited to a distance of three paces from the corresponding non-selected sample.

## The Experimental Area as a Sample

Experimental procedures, as such, do not commonly come to mind when one is discussing the sampling of insect populations. Nevertheless, a set of experimental plots is a sample of a particular universe and should be subject to the same standards and the same restrictions as any other type of sample. As a rule an area used for an experiment on control forms a very small sample as compared with those taken in ecological studies or for purposes of estimating present or future damage; yet if the design and procedures satisfy the mathematical requirements, and the data have been analyzed statistically, conclusions are likely to be drawn with considerable confidence. The possibility that the site and conditions may not be truly representative, or that undesirable variables may not have been removed, is sometimes overlooked. A great deal of thought should be given to the selection of a site for field experiments and to the possible need for duplicate sites in important minor habitats. Failure to remove undesirable variables can increase the error variance to such an extent that true differences, which would otherwise be statistically significant, are effectively masked. At the other end of the scale one should never forget the possibility that his data may have come from the one experiment in 20, or one in 100, in which analysis indicated differences between treatments when, in fact, further work might have reduced the differences to the point where they were not significant. These and several related points are more clearly and adequately covered by Beveridge (1951).

## Sampling Problems Awaiting Solution

As will have been gathered from the foregoing remarks, few, if any, of the sampling problems encountered in grasshopper studies have been completely solved. Although estimates of egg populations have been subjected to formal mathematical tests, still too little is known about the "patterns of variability" of even the major pest species. Mr. L. G. Putnam is now giving this problem further attention. Work under his direction and that of Mr. F. T. Cowan, on methods of sampling nymphal populations, has already been mentioned. The statistical adequacy of methods in general use for sampling adult grasshopper populations is still to be determined. There are innumerable minor problems within these major fields. It is recognized, for instance, that relatively more adults of *M. bivittatus* than of *M. mexicanus* are picked up in a net from a mixed population of these species when one walks slowly than when one moves more rapidly. The same is probably true to a lesser degree in mixed populations of *C. pellucida* and *M. m. mexicanus*. However, the differences have not been critically measured and compared. It also appears that nothing at all is known about the relationship between the true proportions of parasitized and non-parasitized grasshoppers in a given infestation and the proportion picked up in a sweep-net, one of the standard tools for doing such sampling. The effect of weather conditions on the results obtained in sampling adult and nymphal populations requires further study. These and many other problems in sampling grasshopper populations await the attention of workers interested in this very important field.

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# INSECT POPULATIONS IN CARIBOO POTATO FIELDS[1]

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From late June to early September of 1951, 1952, and 1953, insect populations were sampled regularly on 3 farms, 10 miles apart, near Soda Creek, B.C. The objective was to correlate the populations, particularly of leafhoppers, with the natural incidence of witches'-broom virus disease of potato. Little or no disease appeared, but the populations and their dynamics are of interest both in themselves and economically.

Comparative freedom from virus-carrying insect pests has led to the establishment of a thriving seed potato industry in the Cariboo district. The montane climate and swift grow-season ensure that the greatest pest of all, *Myzus persicae* (Sulz.), the green peach aphid, is not often seen and seldom becomes numerous. Most of the growers have never had occasion to use insecticides, nor do they own the necessary equipment.

Since 1949 the western potato flea beetle, *Epitrix subcrinita* (Lec.), has become established in the area, moving northward to Quesnel in 1954. From occasional specimens taken at Soda Creek in 1950 (Prof. G. J. Spencer, University of British Columbia, personal communication), it has increased almost to outbreak proportions, at one site killing the vines and severely damaging the tubers in 1952. In the 3 seasons under review, 85 samples of insects were taken, totalling upwards of 84,000 specimens, of which 91 per cent were adults of *E. subcrinita*. Randomized subsamples of flea beetles, submitted to Dr. L. G. Gentner, Medford, Oreg., confirmed the identity of the species. Of the remaining 7,200 insects, representative samples only were determined.

During the period, recorded monthly temperatures showed very little variation from year to year or from the long-term average, although in 1951 precipitation was below normal.

## Methods

An average of about 2.5 samples were taken per week, each of 100 strokes with a standard 15-inch net. The samples were stratified into 4 subsamples of 25 strokes, taken in each quarter of a field. The subsamples were put together in the killing bottle and the total catch, including immature forms, was counted into the broad, easily recognized categories shown in Figs. 1 and 2.

Exploratory plotting suggested that populations of the insects were similar for corresponding weeks in the 3 years. With this in mind, the 3-years' data in each insect category were grouped into weekly subtotals, divided by the number of samples and

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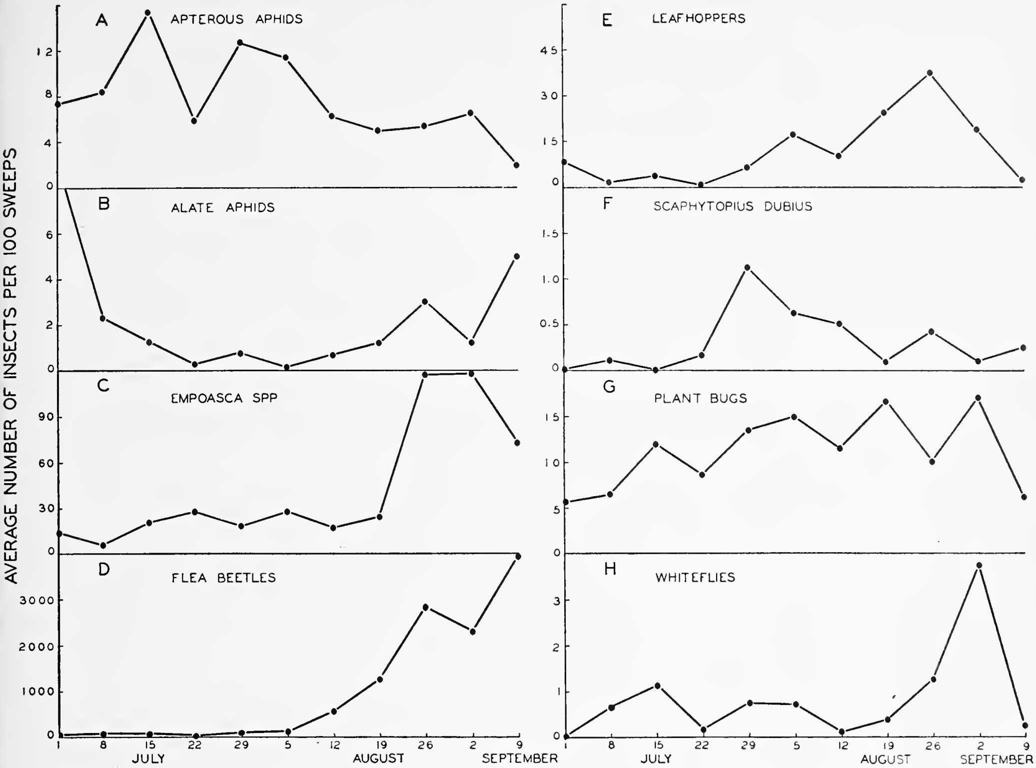


Fig. 1.—Populations of insects collected by sweeping in potato fields at Soda Creek, B.C., during 3 seasons, 1951-1953.

plotted on a common base-line with appropriate *y* axes. Since the sampling and treatment were uniform, the graphs give a fairly reliable picture of the simultaneous development of populations.

## Results and Conclusions

Three groups, normally breeding on potatoes are potentially of major importance to growers. These are: aphids, *Empoasca* spp. of leafhoppers, and *E. subcrinita*. Seven groups, which may or may not breed on potatoes, are of minor importance. These are: leafhoppers other than *Empoasca* spp., plant bugs, whiteflies, psyllids, lacewings, ladybird beetles, and predatory Hemiptera. Four groups are incidental, or were during the years in question. These are: spittlebugs, treehoppers, grasshoppers, and caterpillars.

Examination of alate and apterous aphid samples in alcohol showed them to be overwhelmingly of the potato aphid, *Macrosiphum solanifolii* (Ashm.). The green peach aphid may well have been in the fields, failing to show up because the samples were perforce swept from the upper two-thirds of the vines, thus missing the preferred feeding site of *M. persicae* on the basal leaves, but including that of *M. solanifolii* on the growing tips. The typical hot-weather decline of the apterae (Fig 1, A), and the fall and rise of the alates are well illustrated (Fig. 1, B).

*Empoasca* spp. showed the high peak in late summer expected of prolific insects breeding within the crop (Fig. 1, C). Large, well-irrigated fields had the highest populations, but no crop was appreciably damaged by hopperburn.

Small, unirrigated fields had the highest populations of flea beetles. At these sites, the adults were at their

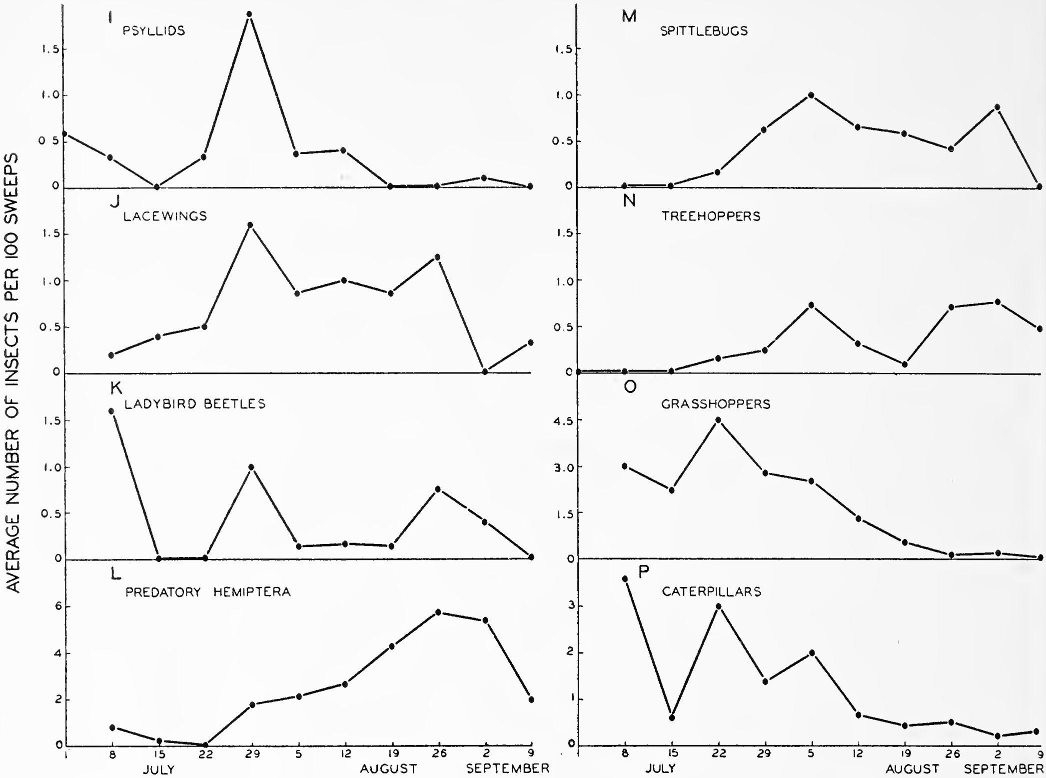


Fig. 2.—Populations of insects collected by sweeping in potato fields at Soda Creek, B.C., during 2 seasons, 1952-1953 (J-M, O, P) or 3 seasons, 1951-1953 (I, N).

peak in early September (Fig. 1, D), to be found not only in the remnant of the crop but also in the brush and on wild land surrounding the potato fields.

A number of leafhopper spceies other than *Empoasca* bred in the crops, producing a similar curve on a lower scale (Fig. 1, E). Determinations made so far indicate that about half of these fall into the genus *Macrosteles,* which includes known and suspected virus vectors. One species instantly recognizable is *Scaphytopius dubius* (Van Duzee), the sharp-nosed leafhopper (Fig. 1, F). This insect is a proved vector of witches'-broom virus disease of alfalfa (Menzies, J.D., 1946. Phytopathology *36*: 762-774), and is suspected of carrying others. It will breed on potato plants in cages, and will do so in the field, to judge by the nymphs sometimes caught well out from field borders.

The plant bugs, with overlapping generations breeding on a variety of plants and fairly strong fliers, show a uniform curve (Fig. 1, G). The number of bugs taken, particularly adults of *Lygus* spp., increased whenever any nearby hay crop was cut.

Most of the whitefly records were made during the dry season of 1951. Neither these nor psyllids constituted much of a threat to the crop (Figs. 1, H, and 2, I). Immature forms of these groups were not taken.

Numbers for the 3 groups of predators combined show a low negative correlation (–.311) with numbers of apterous aphids. The predatory Hemiptera were mostly species of *Geocoris* and *Nabis* (Fig 2, L.).

Treehoppers were most often taken in small fields with brushy borders, but spittlebugs occurred in larger fields, usually close to stands of alfalfa (Fig. 2, M and N).

Grasshoppers in all instars (Fig. 2, O) would be a potential threat to potatoes in the Cariboo were it not that they appear to feed on other plants more readily. Caterpillars Fig. 2, P) taken in 1952 and 1953 were usually of the bertha armyworm, *Mamestra configurata* Wlkr., a species that may approach damaging numbers in small areas, as in 1951. In that summer a disease, a polyhedrosis to judge by the symptoms, reduced the numbers to insignificance within a few days. Growers report this as occurring whenever the bertha armyworm becomes locally numerous.

The following list gives the insect groups other than flea beetles in order of average percentage of total numbers taken; *Empoasca* spp., 48.0; other leafhoppers, 15.4; plant bugs, 14.4; apterous aphids, 9.7; predatory Hemiptera, 2.4; grasshoppers, 2.2; caterpillars, 1.7; alate aphids, 1.2; whiteflies, 1.2; psyllids, 1.2; lacewings, 0.8; *Scaphytopius dubius,* 0.5; spittlebugs, 0.5; treehoppers, 0.4; ladybird beetles, 0.4. The order bears little relation to their importance to the crop, however, and the list is given as a record only.

Although the populations in fields fluctuated in concert, there was nonetheless a tendency for individual fields to have distinctive populations, influenced by size, surroundings, condition of the potato plants, and the presence of weeds.

The population graphs indicate that the most effective period for a single application of a general insecticide is probably the last week in July, when most of the groups were at or approaching a subpeak, as the first summer generations matured. Control measures in the week of July 15 would be equally effective, especially against aphids, but would probably need repeating about August 19. An application at this time would be especially useful against *E. subcrinita,* for it is larvae from eggs laid by adults emerging in mid August that have caused commercial damage.

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## Numbers of Collembola in a Swarm

At a previous meeting of this society I mentioned the way in which Collembola sometimes aggregate.

On 23 April, 1951, I was given a glass jar containing Collembola with the report that they were taken from a cabin on the North Shore Mountains of Vancouver. the day before. The owners of the cabin, going up for the week-end, had found the floor covered, as they said, by a layer of these insects one half inch deep. With a piece of paper, they scooped some into a glass jar and brought the jar down next morning. They were terrified of the carpet of insects and sat up in chairs all night for fear of being eaten alive if they dared to lie down on beds to sleep. The winter's snow lay deep on the ground and the Collembola must have moved up through it and invaded the cabin.

The insects were spread out on a large sheet of paper and air-dried under laboratory conditions. When thoroughly dry, they were weighed and counted. They were 56 c.c. in volume. and weighed 14.207 grams. Six samples of 100 at a time were weighed on a chain balance and averaged, and a total of 1,261,369 was reached for the entire mass. The insects were kindly identified for me by Mr. Lionel Wade of our University (who wrote a Master's thesis on the Collembola of the lower Fraser Valley), as "*Hypogastrura pseudarmata* (Folsom), family Poduridae, a mottled dark blue species extending from British Columbia to California".

What I take to be this species was sent in in quantity some years ago in early spring from a greenhouse near New Westminster and from Stanley Park Greenhouses; in both places the insects were reported to form so thick a layer on the floor that they gummed up the ordinary corn brooms and had to be shovelled out with a coal shovel.

It is of interest to speculate on the causes of such vast numbers of this insect suddenly appearing from apparently nowhere and as to their final disposition.—*G. J. Spencer. University of British Columbia.*

# OBSERVATIONS ON THE EFFECT OF DROUGHT IN INSECT POPULATIONS WITH ESPECIAL REFERENCE TO HETEROPTERA HOMOPTERA AND LEPIDOPTERA

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For many years entomologists have speculated on the causes of fluctuation in insect abundance, some of which are readily explained and others mysteriously obscure. Diseases, predators, parasites, destruction of host plants, storms and drought all play a part in regulating the number of insects. Some observations on the effect of drought on Vancouver Island form the subject of this paper.

The south-eastern part of Vancouver Island has an extremely light summer rainfall, similar to that of the interior dry belt south of Penticton. During the months of June, July and August the area around Victoria is probably the driest part of the Province, the total average rainfall for those months being 1.98 inches; this is a 65-year average. At Sidney the average for 37 years is 2.62 inches. Summer rains of any consequence are unusual and the country becomes dry and parched. This lack of summer moisture may account partly for the scarcity of diurnal lepidoptera on the island. Except for the ubiquitous cabbage butterfly and the small ringlet, *Coenonympha inornata insulana* McD., which is probably the most abundant butterfly on the island, few butterflies are seen during June, July and August. This scarcity of butterflies compared with the numbers which may be seen in the northern Okanagan Valley where summer rains frequently occur is very noticeable. The difference is not only in the number of species, but in the number of individuals of any species. In further comparison, although in Great Britain are found only 68 species of butterflies, some of them rare or occasional visitors, the abundance of butterflies is one of the features of the countryside and no doubt is due to the moist climate and high humidity which enable the food plants to remain lush and green.

Vancouver Island has 49 species of butterflies out of 155 species occurring in British Columbia. The proportionate number of moths is somewhat greater. The comparatively small number of species found on the island is not entirely due to climatic conditions but also to the nature of the country and its vegetation. Whereas the interior of the Province has large areas of open country interspersed with park-like spaces and low-lying ground, affording support for a long list of grasses and plants, Vancouver Island and the coast in general have no such terrain. Formerly several thousand acres of park-like land existed at the southern tip of Vancouver Island, much of which is now covered by the city of Victoria. There is a small area of a similar nature at Duncan and one at Comox and a few wide open patches on some of the islands in the gulf. Elsewhere the forest reaches to the water's edge, so that the area suitable for the growth of herbaceous plants is restricted. Of the 49 species of butterflies on Vancouver Island, 32 are herb or grass feeders, 13 are tree or shrub feeders and the hosts of four are unknown. Thus, drought conditions, by drying up the herbaceous plants and grasses, could well account for the small number of butterflies to be seen. This hypothesis becomes more probable in the light of what happened to insect life during the dry summer of 1951.

In that year the southern portion of Vancouver Island and the adjacent mainland were subject to the longest period of drought that had been recorded for fifty years. On Vancouver Island a continuous period of 95 days occurred, from May 25 to August 27, with not more than a

Average relative humidity and average temperature for 1951 compared with 1950 at Langford Forestry Station during June. July, and August.

| | Average Relative Humidity per cent | | Average Temperature degrees Fahr. | |
|---|---|---|---|---|
| | **1950** | **1951** | **1950** | **1951** |
| June | 68.2 | 66.5 | 62.3 | 65.5 |
| July | 66.2 | 66.4 | 66.1 | 68.3 |
| August | 69.3 | 67.2 | 65.7 | 64.2 |

trace of rain. The drought could be said to have started earlier than that, however, since from May 13 to May 25 only .08 of an inch was recorded, an amount so small as to be negligible. Unfortunately it was not evident until the season was well advanced that a disastrous drought was upon us. Therefore no provision was made for anything resembling a quantitative survey or accurate recording of populations and the fragmentary data which I have been able to assemble result from observations made in the course of collecting trips at various times from May to September.

Through the courtesy of the Provincial Department of Forestry I was allowed to examine the meteorological records of the forestry stations. Those of the Langford Forestry Station, six miles inland, as summarized in the table, were selected as most typical of southern Vancouver Island. Such records are not necessarily representative of the places where insects were collected but reflect conditions in a general way. Relative humidity was unusually low, averaging during the three critical months about two per cent less than the previous year, while the average temperature was about two degrees higher. Moreover, during the hours from 8 p.m. to 4 a.m., the period during which humidity is highest, there was an unusual lag in the increase of relative humidity, the recordings in the first part of the period being exceptionally low. The prevalence of drying, northeast winds was a contributing cause. Also, inversion of humidity was observed. Whereas humidity should be higher on the lower levels and lower on the high levels; the reverse was often the case. These conditions were disastrous to vegetation and to the insects dependent on it. Arboreal species generally suffered less than those which feed on grasses and herbaceous plants but the number of species present on trees and bushes was generally much lower than normal. The effect of the drought conditions was to cause insects to concentrate on small patches of vegetation in shady places where a little moisture remained. Those species which inhabit swampy areas maintained their usual numbers along the banks of streams and estuaries but were killed-out where swamps had dried up. As the season advanced the moisture content of willows and other trees and shrubs, which normally support large numbers of insects, became too low and very few, even of common species, were found on them.

On the other hand, in valley bottoms and alluvial flats, alder trees and willows had the benefit of abundant moisture. Alder trees at the mouth of Goldstream creek were found to have an enormous population of a species of *Empoasca* and a fair number of *Psylla alni* Crawford. On the open grass flats at the mouth of the creek small leafhoppers concentrated on a few square feet of *Poa pratensis* which remained green. At a slightly lower level in a swamp grass and sedge association near tidewater, species of *Cicadula, Macrosteles* and *Sorhoanus* were found in their usual numbers and large numbers of tarnished plant bug nymphs were present with them.

On the river flats at Cowichan Bay a very large and luxuriant bush of *Salix scourleriana* growing close to the Cowichan river, where the water table could have been only a short distance below, was found to be swarming with a species of *Empoasca* and a considerable number of Nabidae and other insects. Less than twelve sweeps of the net secured 206 Homoptera. By contrast, the same species of willow growing at a higher level out of reach of the influence of the water, yielded only 53 specimens of several species in about a hundred yards of sweeping. Thus, the survival of species and the extent of population was governed by the amount of moisture available. Insects were found to concentrate on any small oases formed by seepage from springs or on the banks of lakes or rivers with Homoptera predominating. Generally very few Heteroptera were found in proportion to Homoptera, except in some moist shaded spots where herbage remained green, Miridae being exceptionally scarce everywhere.

Having had long experience with the Heteroptera and Homoptera of this region I made an attempt to estimate the population of 64 species in terms of per cent of normal numbers. I found that of 42 grass and herb feeders, 30 species had decreased 70 to 95 percent, 8 species had decreased 30 to 50 per cent, and 4 species were in normal numbers. Of 16 tree and shrub feeders, 6 had decreased 70 to 95 per cent, 3 species had decreased 30 to 50 per cent, 5 species were in normal numbers, and two species of *Empoasca* showed an increase of 200 to 400 per cent. However, these estimates were made in localities favourable for insects. A properly organized quantitative survey over the entire district would have produced much lower averages. The two species of *Empoasca* on alder and willow, one of which was present in twice and the other in four times their usual numbers, were abundant only in exceptionally favourable spots and their numbers were probably augmented by migrants from trees on land where less moisture was available.

Predaceous species were similarly affected and the few that were obtained appeared to have decreased 50 to 80 percent. Several species of leafhoppers which are usually abundant seemed to have disappeared altogether. Of these *Aceratagallia sanguinolenta* Prov., a very small leafhopper which is usually abundant on grasses, was not found at all and had not reappeared three years later. However, the disappearance of this formerly very common species is linked with other causes, for it was found to be scarce in other parts of British Columbia not affected by drought in 1951. In three days of collecting at Kamloops by Mr. E. R. Buckell in 1954 only one specimen was obtained; collecting by myself at the same spot a few weeks later produced two, and one was taken at Spence's Bridge. None was found in the Fraser Valley or on Vancouver Island in 1954. The additional factor of drought at the coast appears to have reduced this species to such an extent that it may take many years to recover its numbers in that region. Others of the same group also were absent. Several species of small leafhoppers which feed on grasses were reduced to negligible numbers but were locally abundant the following year. The small ringlet butterfly which is usually abundant was scarcely seen at all. In fact, the number of species of various orders which were reduced by the drought would make an extensive list.

On the other hand, a few species either were unaffected or were benefited by the weather conditions. A heavy infestation of the aphis *Myzocallis punctatus* Monell occurred on Garry Oaks throughout the southern end of Vancouver Island, in fact, the worst that had occurred in recent years. This infestation did not result from an exceptionally favourable supply of moisture but from other conditions which could have been a decrease of parasites and predators due to drought or other causes. Many other species of aphids were abundant. It is worth noting in this connection that Hemerobiids and Chrysopids were exceptionally scarce that year and very few Coccinellids and Syrphids were seen. The *Myzocallis* infestation was greatly reduced in 1952, was still less in 1953, and in 1954 the species had nearly disappeared, which suggests that if drought was responsible for the decrease of predators they required three years to recover their numbers. Also on Oak trees a small moth, *Gelechia trichostola* Meyr, occurred in unusual numbers. This species was heavily reduced during the next two years. The codling moth was abundant on Vancouver Island and the long period of warm weather and higher average temperature induced a partial second generation which is unusual at the coast. Other economic species which showed an increase were the apple leaf skeletonizer, *Anthophila pariana* (Clerck); the cherry fruit flies, *Rhagoletis cingulata* (Loew) and *R. Fausta* O.S.; the European earwig, *Forficula auricularia* L.; *Typhlocyba ariadne* McA. and *T. tenerrima* H.S. on loganberries; *Lecanium coryli* (L.);*Polyphylla perversa* Csy. in strawberries; the strawberry crown moth *Ramosia bibionipennis* (Bdvl.); cutworms and wasps.

In the lower Fraser Valley insects appeared to be affected in much the same degree as on Vancouver Island. Most species were greatly reduced in numbers. During the latter part of the summer very few insects were present on trees and shrubs, except where abundant moisture was available as in the case of poplars or other species growing near water or where watering was carried out in cities.

It is fairly obvious that the principal cause of the high mortality among Heteroptera, Lepidoptera and most of the Homoptera was the destruction of food plants. The reason that a number of species were able to increase and others maintained normal numbers is not clear, although most of them were tree or shrub feeders, which have a distinct advantage over grass and herb feeders in a dry season. But the factors governing insect populations are tremendously involved and include the presence or absence of predators, parasites and diseases. These in turn may be affected by temperature, moisture and humidity. The tolerances of insects with regard to temperature, moisture and humidity vary according to the species and although rains may fall in an otherwise normal season, it is important that they fall at the right time to provide sufficient humidity at the critical period of development for any individual species. Writers on the subject have suggested various results from the lack of sufficient humidity. Ludwig (1945, p. 107) states: "Ludwig and Anderson (1942) observed that, when the eggs of Saturniid moths were exposed to low humidity, many more larvae developed than emerged. In dry air many larvae pierced the shells but died without emerging. Hence, in these eggs the chorion is very efficient in preventing evaporation, retaining this function until pierced by the emerging larvae. Thereupon the larvae lose water so rapidly in dry air that very few of them are able to hatch." . . . "In some cases the limits of humidity which permit hatching are narrower than those which permit development, indicating that at the lower humidities, death occurs because the larvae are so weakened by loss of water that they cannot emerge or because desiccation hardens the chorion to such an extent that the larvae are unable to escape", (Pyenson and Sweetman, 1931).

The degree of humidity definitely influences the reproductive capacity of insects. "Low humidity may reduce the number of eggs laid by interfering with the mechanism of oviposition". (Ludwig 1945, p. 110). A combination of heat and dryness may cause desiccation of the pupae of insects. This is evidenced in the well-known case of the Hessian fly, for which drought conditions are unfavourable, since the larvae and pseudopupae are easily killed by dryness. The adults also die prematurely without realizing their productive abilities. Eggs do not hatch successfully, or young larvae are unable to reach the tender parts of the stem.

The recovery of Heteroptera and Homoptera after the year of drought was, for a large number of species decidedly slow. In 1952, except for those species which are always reasonably abundant, few insects were collected even in favourable spots, although the summer rainfall was slightly above the average. In 1953 there was an increase in numbers although still not up to the average. What I would consider normal conditions were not reached until 1954, although even then certain species were still absent. Those species which I mentioned as occurring in abnormal numbers in 1951 were reduced to minimum populations the following year, which is usually what happens following over-abundance. To correctly assess the effect of weather variations on insects is a most difficult matter for, apart from the direct effect of destruction of food plants, intolerance to excessive heat and low humidity, the actions of predators, parasites and diseases have to be taken into account, and as these vary with each species, the problem becomes exceedingly complex. Periods of abundance may be long or short according to the species, and weather cycles may have a direct effect on the length of these periods. Thirty-five years ago many species of Heteroptera and Homoptera were much more abundant than they are now. I have not seen some of the species which were abundant then, for twenty years or more; and some have re-occurred only occasionally. But eventually when favourable conditions return, each species will regain its former abundance.

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# NOTES ON THE LIFE HISTORIES OF FOUR SPECIES OF MOTHS (LEPIDOPTERA: PHALAENIDAE) INDIGENOUS TO VANCOUVER ISLAND, BRITISH COLUMBIA

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Among several life histories and partial life histories, worked out during the year 1954 the following are submitted as a contribution to our knowledge of local entomology.

**Ulosyneda subtermina** Sm.

This is a Western American species, occurring from British Columbia to California. In British Columbia it seems to be confined to Vancouver Island, wherever its food plant the Garry Oak (*Quercus garryana*) grows. Information regarding the early stages is not readily obtainable, at any rate I am not aware of any published records.

Although not a conspicuously coloured moth it is quite distinctive, with shades of ashy brown dotted with black at tip of forewings, and etched with darker lines, unlike any other moth of similar size and appearance. It measures one and one half to one and three quarter inches (40-47mm.) in wing expanse. It is a night flier, and is readily attracted to artificial light in the vicinity of the Garry oak during the months of April and May.

Material for the present account was obtained in a light trap. A female taken on May 11 was confined in a jar with several dead oak leaves. Twenty-five eggs were laid in a compact group under one of the leaves where it was in close contact with the bottom of the jar, suggesting what in fact is the case, that the ovipositor is long and flexible enabling the moth to lay her eggs well into the crevices of bark or twig.

**Ovum.** Laid May 11th. Size 1 by 1 mm. At first globular, soon losing this form due to pressure of the other eggs or contact with the substratum; shell very fragile, membranous, hyaline, easily conforming to the irregularities of site and position, more or less translucent, with very faint ribs and cross ribs, contents showing as an amorphous creamy substance. During the development of the larva within the egg the only change noted was an obscure dark spot in the centre of the creamy contents.

**Larva**

**1st Instar.** May 22; newly hatched larva 4 mm. in length. It did not eat the egg membrane. Bilobed head and cervical plate shiny, dark chocolate in colour. Body smooth with segments well marked by intersegmental constrictions, colour a very pale translucent green. Three pairs of claspers. The young larva is very active, looping along rapidly and with much swinging of the body in all directions, evidently in search of food. When disturbed it emits a light silken thread that prevents it from falling to the ground. At all times it avoids the light, feeding between the Garry oak leaves or within their curled edges. When at rest it stretches out along the underside of a leaf.

**2nd Instar.** May 28; length 5-7 mm. Head dark brown or black. Body colour now light green to blue grey, with a series of six longitudinal indistinct or interrupted pale brown lines; spiracles black. At a later stage in the second instar the subdorsal lines show a well marked intermittent thickening and thinning on each segment, giving the effect of a series of short dashes, one on each segment. Below the subdorsals are two very thin whitish lines followed by a broader light grey spiracular line. The spiracular line merges into the dull soiled-white colour of the underside. The larva is negatively phototropic. If exposed to the light it lies still momentarily, then rapidly wriggles under cover of the leaves or the scraps of lichen-covered bark provided for it.

**3rd Instar.** June 9; length 10 mm. Head black. General colour grey to bluish-green. A faint bluish-green dorsal line. Subdorsals with well marked bracket-like dashes on each segment. A dark spot between the dashes gives a chain-like appearance to each of the subdorsals. Several fine milky white lines between the subdorsals and the spiracular line. As it grows larger the larva tends to abandon the leaves when not feeding, which is only at night, and seeks the cover of the bark and lichens at the bottom of the cage. It closely resembles the lichens among which it lies and from which it is almost indistinguishable.

**4th Instar.** June 20; length 20 mm. Head square, black on lower part of front blending into grey-green on vertex, an oblique fuscous dash on each side, cervical plate grey-green marked with two parallel dark brown bars one on each side. Body dark fuscous olive, a faint white-edged bluish dorsal line, subdorsal interrupted marks very conspicuous, these marks slightly curved, the convex side towards the dorsum. Ground colour of body finely etched with drab olive colour. Length at end of 4th instar 30-35 mm.

**5th Instar.** June 27; length 32-34 mm. Head as before, colour pattern intensified by contrasting light and dark greys, dorsum of body segments with a pale grey-green anchor, or hourglass-shaped marking. Thickened sections of the subdorsals conspicuous, a broad light grey super-spiracular line blends into the pale drab colour of the underside. Five well-developed claspers, those on the fourth and fifth abdominal segments having developed during the last two or three moults. Length, just before pupation, averaged 42 mm.

**Pupa.** Pupation took place July 18 in a light cocoon spun among the debris at the bottom of the container. Length 20 mm. x 5 mm. slender, tapering posteriorly, surface dull, colour dark reddish-brown, cremaster consisting of two stout, straight, widely spaced spines, and a short slender one at the base of and on the outer side of each of the larger spines.

**Summary.** The eggs are laid in the spring, presumably in a crevice of the bark or between bud scales, their flexible texture allowing of a close application to the irregularities of the suffrace on which they may be deposited. The larva is very active when first hatched. Throughout all instars, the larva is negatively phototropic. It hides at first among the leaves, later in the crevices on the bark among the lichen growth, the colour and marking of which it resembles. At first possessing only three pairs of claspers it develops an additional two pairs in the last moults. At all times the larva is essentially an individualist.

In 1954, eggs laid May 11 hatched on May 22, 11 days; 1st instar 6 days; 2nd instar, May 28, 12 days; 3rd instar June 9, 11 days; 4th instar, June 20, 7 days. The 5th instar began June 27 and lasted 22 to 28 days, the feeding period being about 16 days, the larva remaining quiescent in the cocoon for a week or so before pupating. Pupated July 18 to 24, *i.e.,* 69 to 75 days from egg to pupa.

### **Caenurgina erechtea parva** Blkme

The forage looper or common grass moth is widely distributed in North America from coast to coast in open grassy places where it flies on sunny days. It occasionally comes to artificial light.

In British Columbia it is double brooded, the spring form being considerably smaller than the summer one. It was to the small spring form that Blackmore (1920) gave the name *parva.* Ferguson (1953) in his Lepidoptera of Nova Scotia, also mentions the small spring form of this species, so this seasonal dimorphism apparently occurs over a wide range. I have no evidence yet as to whether the summer form passes the winter in the pupal or larval stage. This might have a bearing on the occurrence of the smaller specimens of spring. In some species of moths, for instance, *Xanthorhoe defensaria,* the spring form is the largest.

Eggs were obtained from an individual of the summer brood (*erechtea*) on July 26, 1953. These hatched on August 4 but all the larvae died from lack of the proper food plant which was not known at that time. As the commoner vetches, which constitute the food plant of the spring brood, are drying up at that season of the year, there may be an alternate and as yet unknown food plant of a more succulent type.

**Ovum.** Female taken in the Hudson's Bay Woods, Victoria, Vancouver Island, laid 30 ova on May 4, 1954. They were scattered about the bottom of the box, each one lightly cemented to the surface. Length about 1 by 1 mm., spherical and finely ribbed, colour grass-green, irregularly spotted with brown.

**Larva**

**1st Instar.** May 18, length 3 mm. Head colourless. Body translucent, three pairs of claspers. Very active, looped rapidly about, emitting a light silken thread as it proceeded. Did not eat shell. Fed on *Trifolium pratense, Vicia sativa, Trifolium dubium* and *Lathyrus nuttallii*; it nibbled at *Dactylus glomerata,* but preferred *Vicia sativa.*

**2nd Instar.** May 24, length 6 mm. Head pale brown, body green with six thin brownish longitudinal lines; spiracles black, claspers brown at tip.

**3rd Instar.** June 2, length 10 mm. Head light brown with darker brown and white stripes. Body grey green to blue grey; four double longitudinal brown stripes continuous with those on the head. Under side grey with four dark brown longitudinal lines.

**4th Instar.** June 11, length 15 mm. Colour and markings as before except that the under side has a black white-edged central line flanked by three thin fuscous lines on each side, thoracic legs dark brown. When disturbed raises the front part of body, doubling the head back along the under side. When at rest it lies closely appressed in full length along the stem of food plant. As the body tapers slightly at each end it blends into the stem, the double longitudinal lines further helping to camouflage it.

**5th Instar.** June 20, length 25-35 mm. Head light brown with lines as before although some larvae have head black with a central light brown line; body brownish to fuscous, original double lines less strongly marked. By July 12 it was full-fed. General colour a dead-grass shade of yellowish-brown varying from light ash to sienna brown in some individuals; the double lines traceable and with numerous fine lines and vermiculations between that help to break up the solid effect of a plain colour. Most of the lavae pupated at this time, spinning a light cocoon among the leaves of the food plant.

**Pupa.** Length 17 mm. x 5 mm. Reddish-purple colour with a glaucous bloom; cremaster consisting of four separated hooked spines in a row along the broad tip of the last segment.

**Imago.** On August 5, four emerged; on August 6, one; on August 7, five; August 8, two; August 11, two; all females but one. Thus fourteen adults were reared from thirty eggs. These were the large or summer brood originally described as *erechtea.*

*Caenurgina erechtea* measures one and one half inches (42mm.) across the expanded wings; while in the form *parva* it is only one and one quarter inches (34 mm.) from tip to tip.

**Summary.** Egg May 4 - 18 (14 days). Larva May 18 - July 12 (46 days). Pupa July 12 - August 5 - 11 (27 days approximately). Total period from egg to adult averaged about 87 days.

**Caenurgina caerulea** Grt.

The blue grass moth occurs only in the Pacific coastal regions; in British Columbia it is found on Vancouver Island and in the Lower Fraser valley where it frequents grassy fields, and open slopes on hillsides at slightly higher elevations than *erechtea.* It is on the wing from April to June, flying by day in bright sunshine.

The blue grass moth has the distinction of being one of the very few blue moths. It measures one and one quarter inches (32 mm.) across the expanded wings.

**Ovum.** A female taken on Wells Mountain, Goldstream, Vancouver Island, laid a batch of 30 eggs on June 9, 1954, scattered and lightly cemented to bottom of box. Size .8 mm. x .8 mm. globular, with about 30 fine ribs, slightly flattened at point of adherence to substratum. Colour, grass-green becoming spotted with brown as development proceeds. Hatched on June 27.

**Larva**

**1st Instar.** Length 3 mm. Very slender. Head pale brown, body colourless, translucent, a few long hairs on each segment. All hatched by June 29. Very restless; did not eat egg shell. Fed on *Vicia sativa* and *Lathyrus nuttallii.* Used a silk thread when moving about. Has three pairs of claspers.

**2nd Instar.** July 5, length 6 mm. Head pale brown; body smooth, hyaline showing green patches due to ingested food, two black longitudinal lines on dorsum, underside light grey. Towards the end of this instar the colour was more decided; blue-grey with double lines as in *C. erechtea.*

**3rd Instar.** July 19, length 15 mm. Colour light brownish, otherwise as before. Rested with body stretched out and closely applied to the stem, head and anal claspers extending along the stem so that the body seemed to be part of it.

**4th Instar.** July 28, length 25 mm. Very similar to *erechtea* but no black lines on underside. July 31, length 30 mm. General colour beige or dried grass colour. Dorsal, subdorsals and spiracular lines with a fine grey line down centre of each one giving the effect of double lines (several finely etched lines between are not conspicuous). Underside with a small hyphen-like mark on centre of each segment. There was a tendency for all the markings to become less noticeable as the larva grew older.

**5th Instar**. August 15, length 35-40 mm. Head, beige to pale pinkish brown. General colour a dead grass hue tinged with pink, the four longitudinal double lines extending along the sides of the head as before, though very faintly marked. Development of the individual larvae was very irregular, some attaining twice the size of others towards the end of the larval life; hence pupation extended from August 21 to September 2. A light cocoon was spun among the leaves of the food plant.

**Pupa.** Length 13 mm. x 4 mm. Slender with a light bluish "bloom"; intersegmental areas of abdomen orange-brown, cremaster of two long and several short bristles with recurved tips in a transverse row on rounded tip of segment.

**Summary.** Egg June 9 - June 27 (19 days). Larva June 27 - August 25 (approximately 60 days). Pupa August 25 - May or June of the following year, 8-10 months. Total period egg to adult approximately 360 days.

**Discussion.** Considering the difference in size and colour of *erechtea parva* and *caerulea*, the ova, larvae and pupae are remarkably similar. In *erechtea parva* the larva is larger when full grown, and has several dark longitudinal lines on the underside. The pupa is also larger with the tip of the cremaster bearing four large spines, whereas in *caerulea* there is only one interrupted dark line on the underside. The pupa of *caerulea* has two large spines and several small ones on the cremaster.

The period of development from egg to pupa is sixty days in *parva* and eighty days in *caerulea.*

## Polia liquida Grt.

*Polia liquida* is a medium-sized moth measuring about one and one half inches across the expanded forewings. the general colour is a dark grey with strongly contrasting silvery-white markings. It is nocturnal and readily attracted to artificial light during the flight season, from May to June on Vancouver Island. *P. liquida* is a western North American species. In British Columbia it is recorded from southern Vancouver Island and Kaslo (Jones, 1951); elsewhere it occurs in the coastal states south to California (Dyar, 1902) and east to Montana (Cook, 1930). Farther east it is replaced by closely allied species.

**Ovum.** A female taken at light on June 30, 1954, at Braefoot, Saanich, Vancouver Island, laid a batch of 40 eggs on July 4. They were deposited in a compact layer adherent to the bottom of the container. Size 0.9 by 0.7 mm., orbicular, slightly flattened from above with about 30 strongly marked vertical ribs, reticulate in the micropylar area; colour, pale cream changing through vinaceous pink to a dark pinkish-red at hatching time.

**Larva**

**Ist Instar.** July 14, length 3 mm. Head pale brown. Body colourless with large black tubercles, about eight to each segment. The larva eats the egg shell and is very restless, not feeding until about twenty hours later. It nibbled at *Agropyron repens, Lathyrus nuttallii,* and *Rumex crispus* the last of which it much preferred and on which it was reared to maturity. When alarmed it rears up, bending the head and fore part of the body downwards in a question-mark-like attitude.

**2nd Instar.** July 30, length 7 mm. Head pale brown, body pale greenish or in some individuals a fuscous colour with bluish dorsal and subdorsal lines, a broad whitish spiracular line edged with black along the upper side. Underside honey-colour, third and fourth pairs of claspers more strongly developed than the first and second. One larva was observed to forcibly remove an obstinate pellet with its jaws.

**3rd Instar.** Length 16 mm. Head pale brown with two vertical dark brown bars, body fuscous or brown, the longitudinal lines a pale lemon colour, spiracular line white to yellow edged above with dark brown.

**4th Instar.** August 17, length 25-28 mm. Head as before, body a dark chocolate colour, all the stripes, including the spiracular, a pale lemon colour each finely edged with black.

**5th Instar.** August 26. Length 35 mm. Head pale brown with four vertical fuscous bars, body chocolate with strongly contrasting black-edged yellow dorsal, subdorsal and spiracular lines. In some cases body colour is black between dorsal and subdorsals, vinaceous between subdorsals and spiracular, underside vinaceous, shading into beige. Length when full-fed 40 mm.

As the larva grew older it rested quietly, when not feeding, extended along a leaf-stalk or on the mid-rib on the underside of a leaf, the yellow stripes of the larva tending to blend it into the leaf or stalk. If touched it rolled into a ring and dropped to the bottom of the container.

**Pupa.** Pupated September 7 and 8. Pupa 17 mm. x 5 mm., slender, thorax with fine transverse rugosities or wrinkles, abdominal segments coarsely punctate except for a smooth central band on the first three; colour dark mahogany brown; cremaster a stout dorso-ventrally flattened process terminating in two parallel spines, the whole 1 mm. long. The larva made a cocoon of earthen particles cemented together with silk, just beneath the surface of the ground.

**Summary.** Ovum, July 4 - 14 (10 days). Larva July 14 - September 8 (57 days). Pupa September 8 - May or June (8-10 months). Total days from egg to adult approximately 365 days.

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## Insect Population in Pigeon Manure

On February 16, 1954, a citizen brought me about a gallon of pigeon manure from the belfry of an old church in Vancouver, stating that it was a sample from some two tons that had accumulated over the years. A farmer had contracted to remove the manure. Finding certain insect larvae in it, he wondered if the insects would be detrimental to his greenhouse crops and asked his friend to have the material examined.

The manure was fairly solid and compressed, damp and heavy with odd sticks and feathers and the remains of a dead bird incorporated into it; the surface, of recent deposition, was dry and flaky. There was relatively little smell to it.

Picked over bit by bit, it yielded:—

1. Scores of larvae of *Tenebrio molitor* L., the yellow meal worm, in all sizes and instars from very small to mature—but no pupae or adults; there was one elytron.
2. Many dead adults of *Sitodrepa panicea* L., the drugstore beetle, but no larvae.
3. Two adult *Ptinus fur* L., the white-marked spider beetle, and one larva, all alive.
4. Several small Staphylinid bettles.
5. Moth larvae of two distinct species, one fully ⅜ inch long, active, and non-silk spinning.
6. A few empty cases of *Tinea pellionella* (L.), the case-making clothes moth.
7. A number of full grown, thin, thread-like larvae of *Scenopinidae,* window flies. These maggots have distinct heads and are predacious.
8. Many predacious, small Hemiptera, two adults and the rest nymphs. I have not identified them yet.
9. Two half grown, living *Lepisma saccharina* L., or silver fish,
10. Two empty puparia of, probably, blow flies.

To my surprise, there were no mites and no larvae of muscoid Diptera; none of the insects was of much nuisance value.

—*G. J. Spencer, University of British Columbia.*

# CHEMICAL CONTROL OF *LYGUS* SPP. (HEMIPTERA:MIRIDAE) IN BRITISH COLUMBIA PEACH ORCHARDS*

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Before 1949, the quantity of marketable fruit from many peach orchards in the interior of British Columbia was appreciably reduced because of malformed peaches. Most of this malformation was due to the feeding of *Lygus* bugs, which are particularly abundant where alfalfa cover crops are grown. The only feasible means of controlling these insects was by disking under the cover crop in the fall, and frequently this practice was not very successful.

From 1947 to 1952, experiments were conducted in peach orchards throughout the Okanagan Valley of British Columbia on the control of *Lygus* bugs with DDT and other organic insecticides.

## Materials and Methods

In the early experiments, the insecticides were applied as dusts to the orchard cover crops only, but as the work progressed the peach trees were sprayed, generally with a mist-blower sprayer. The area of each treated block was usually about one acre; treatments were not replicated. Control of *Lygus* bugs was estimated from the percentage of malformed fruits at thinning time and at harvest. The insecticides, their amounts and the stages of tree development at which they were applied are given in Tables I to VII.

## Results and Discussion

In three orchards where the cover crop alone was dusted (Table I), it was only in the first orchard, treated with DDT at the balloon-bud stage of peach, that the percentage of malformed fruit at harvest in the treated block was appreciably lower than in the check block. In the other orchards, the insecticides were probably applied too early (early balloon-bud stage of peach) for the most effective control of *Lygus* bugs.

**TABLE I.—Malformed Fruit at Thinning Time and at Harvest After Dusting the Cover Crop in Three Peach Orchards with DDT or BHC, 1947.**

| Orchard | Material | Approximate Amount per Acre | Stage of Peaches when Cover Crop Dusted | Fruit Malformed %[1] | |
|---|---|---|---|---|---|
| | | | | Thinning Time | Harvest |
| 1 | DDT, 3% dust[2] | 80 lb. | Balloon-bud | — | 7.4 |
| | Check | No treatment | | — | 19.7 |
| 2 | DDT, 3% dust | 150 lb. | Early balloon-bud | — | 9.7 |
| | Check | No treatment | | — | 9.1 |
| 3 | BHC, dust[3] 2% gamma isomer | 2.3 lb. gamma isomer | Early balloon-bud | 8.3 | 6.4 |
| | Check | No treatment | | 10.1 | 7.2 |

[1]Each figure is determined from 1500 fruits examined at random.
[2]Ansell Laboratories Limited, Vernon, B.C.
[3]Shanahan's Limited, Vancouver, B.C.

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On the basis of the percentages of malformed fruit at harvest, the population of *Lygus* bugs was evidently reduced where peach trees were sprayed twice with a mixture of BHC, stove oil, and Velsicol AR-50 (Tables II and III). Strict comparisons cannot be made since two orchards were involved and the dosages of the chemicals were slightly different in the two orchards. However, where the BHC spray was applied at 95 per cent petal-fall and again at 95 per cent shuck-fall (Table II), the percentage reduction in malformed fruit at harvest was similar to that obtained when it was applied at the late balloon-bud stage and again at 95 per cent shuck-fall (Table III). On the basis of the percentages of malformed fruit at harvest, the BHC spray in the latter orchard appeared to give only slightly better control of *Lygus* bugs than a mixture of DDT, stove oil, and Velsicol AR-50. According to the grower, however, in previous years damage from *Lygus* bugs had always been more severe in the area in which the BHC and check blocks were situated, because of a dense alfalfa cover crop, than in the DDT block, where there was virtually no alfalfa. The superiority of BHC over DDT was, therefore, probably greater than indicated by the percentages of malformed fruit. The poorer results with DDT were, no doubt, largely due to the low dosage (one pound of DDT per acre) used in the experiment.

**TABLE II.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees with a Mixture of BHC, Stove Oil, and Vilsicol AR-50 at about 95 per cent Petal-fall and again at about 95 per cent Shuck-fall, 1948.**

| Material | Approximate Amount per Acre per Application | Fruit Malformed, %[1] Thinning Time | Fruit Malformed, %[1] Harvest |
|---|---|---|---|
| BHC wettable powder[2] 6% gamma isomer | 0.75 lb. gamma isomer | 5.3 | 8.6 |
| Stove oil[3] | 9.0 pints | | |
| Velsicol AR-50[4] | 9.0 pints | | |
| Duponol WA flakes[5] | 2.0 oz. | | |
| Check | No treatment | 11.2 | 13.7 |

[1]Each figure is determined from approximately 2000 fruits examined at random.
[2]Canadian Industries Limited, Montreal, Que.
[3]Approximately 32 S.S.U. Vis. 100°F., over 75 per cent U.R.; Shell Oil Company, Penticton, B.C.
[4]A methylated naphthalene; Velsicol Corporation, Chicago, Ill.
[5]Forty to forty-two per cent sodium lauryl sulphate; Canadian Industries Limited, New Westminster, B.C.

Good control of *Lygus* bugs was obtained in two orchards where a mixture of DDT, stove oil, and Velsicol AR-50 was applied at about 90 per cent petal-fall and again at about 90 per cent shuck-fall (Tables IV and V). Control was slightly less where trees were sprayed at 90 per cent petal-fall only, but the percentage increase in malformed fruit was not sufficiently great to justify the additional expense of the second application (Table V).

**TABLE III.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees at the late Balloon-bud Stage and again at about 95 per cent Shuck-fall with a Mixture of Stove Oil and Velsicol AR-50 containing DDT or BHC, 1948.**

| Material | Approximate Amount per Acre | | Fruit Malformed, %[1] | |
|---|---|---|---|---|
| | Balloon-bud | Shuck-fall | Thinning Time | Harvest |
| DDT[2]<br>Stove oil<br>Velsicol AR-50<br>Nacconol NR[3] | 1.0 lb.<br>1.0 pint<br>0.5 pint<br>1.0 oz. | 0.75 lb.<br>—<br>—<br>— | 15.5 | 12.5 |
| BHC wettable powder<br>6% gamma isomer<br>Stove oil<br>Velsicol AR-50<br>Duponol WA flakes | 1.0 lb.<br>gamma isomer<br>2.0 gal.<br>0.5 gal.<br>8.0 oz. | 1.0 lb.<br>gamma isomer<br>1.0 gal.<br>—<br>6.0 oz. | — | 10.2 |
| Check | No treatment | No treatment | 14.9 | 19.2 |

[1]Each figure is determined from approximately 1700 fruits examined at random.
[2]Technical, Monsanto Chemical Company, St. Louis, Mo., at the balloon-bud stage; 5 per cent powder, Ansel Laboratories Limited, Vernon, B.C., at the shuck-fall stage.
[3]An alkyl aryl sulphonate; National Aniline Division, Allied Chemical and Dye Corporation, New York, N.Y.

**TABLE IV.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees with a Mixture of DDT, Stove Oil, and Velsicol AR-50 at about 90 per cent Petal-fall and again at about 90 per cent Shuck-fall, 1948.**

| Material | Approximate Amount per Acre | | Fruit Malformed, %[1] | |
|---|---|---|---|---|
| | Petal-fall | Shuck-fall | Thinning Time | Harvest |
| DDT, technical[2]<br>Stove oil<br>Velsicol AR-50<br>Duponol WA flakes | 9.0 lb.<br>1.5 gal.<br>1.5 gal.<br>3.0 oz. | 6.0 lb.<br>1.0 gal.<br>1.0 gal.<br>3.0 oz. | 2.5 | 2.8 |
| Check | No treatment | No treatment | 27.4 | 14.3 |

[1]Each figure is determined from approximately 3300 fruits examined at random.
[2]Pennsylvania Salt Manufacturing Company, Tacoma, Wash.

A petal-fall spray of DDT gave slightly better control of *Lygus* bugs than a balloon-bud spray (Table VI). The percentage differences in malformed fruit from sprayed and unsprayed trees were not great, suggesting that control was not particularly good. However, this was probably not so, for the initial population of *Lygus* bugs was much greater in the sprayed blocks, where there was an abundance of alfalfa, the preferred host of *Lygus* bugs, than in the check block, where there was virtually no alfalfa.

**TABLE V.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees with a Mixture of DDT, Stove Oil, and Velsicol AR-50 at about 90 per cent Petal-fall and again at about 90 per cent Shuck-fall, or at about 90 per cent Petal-fall only, 1948.**

| Block | Material | Approximate Amount per Acre | | Fruit Malformed, %[1] | |
|---|---|---|---|---|---|
| | | Petal-fall | Shuck-fall | Thinning Time | Harvest |
| 1 | DDT, technical[2]<br>Stove oil<br>Velsicol AR-50<br>Duponol WA flakes | 4.9 lb.<br>7.3 pints<br>7.3 pints<br>1.6 oz. | 6.0 lb.<br>8.0 pints<br>8.0 pints<br>2.0 oz. | 1.3 | 2.2 |
| 2 | Same as Block 1 | Same as Block 1 | No treatment | 3.2 | 3.1 |
| 3 | Check | No treatment | No treatment | 16.7 | 14.8 |

[1]Determined from approximately 2500 fruits examined at random in each block.
[2]Monsanto Chemical Company, St. Louis, Mo.

As a result of these and other experiments not reported here, a petal-fall application of DDT is recommended for the control of *Lygus* bugs in British Columbia peach orchards. The petal-fall spray of DDT was considerably more important than the shuck-fall spray, and slightly more effective than the balloon-bud spray (Tables V and VI). Chandler (1950) found that, in Illinois, a DDT spray applied when 50 per cent of the peach blooms were open gave even better control of *Lygus* bugs than a petal-fall spray. However, as Snapp (1947) has pointed out, the petal-fall application is preferable, in order to avoid poisoning insect pollinators, even though insects do not play an important role in the pollination of peaches. In British Columbia, cherry trees are often interplanted with peaches. As cherries bloom at approximately the same time as peaches, and as insects are essential for the pollination of many varieties of cherry, every precaution should be exercised to safeguard insect pollinators.

A petal-fall spray of parathion gave slightly better control of *Lygus* bugs than a DDT spray applied at the same stage (Table VII). However, work with parathion was discontinued because of its extreme toxicity to man.

**TABLE VI.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees with 50 per cent DDT[1] Wettable Powder at 16 lb. per acre at about 90 per cent Petal-fall, or at the Balloon-bud Stage, 1952.**

| Stage of Spraying | Fruit Malformed, %[2] | |
|---|---|---|
| | Thinning Time | Harvest |
| Petal-fall | 2.0 | 1.2 |
| Balloon-bud | 4.0 | 1.4 |
| No treatment | 7.8 | 3.4 |

[1]General Chemical Company, New York, N.Y.
[2]Each figure is determined from approximately 1500 fruits examined at random.

**TABLE VII.—Malformed Fruit at Thinning Time and at Harvest after Spraying Peach Trees at about 75 per cent Petal-fall with DDT, or Parathion, 1949.**

| Material | Approximate Amount per Acre | Fruit Malformed, %[1] | |
|---|---|---|---|
| | | Thinning Time | Harvest |
| Parathion, 15% wettable powder[2] | 7 lb. | 3.2 | 2.5 |
| DDT, 50% wettable powder[3] | 15 lb. | 6.1 | 6.7 |
| Check | No treatment | 22.0 | 26.0 |

[1]Each figure is determined from approximately 1200 fruits examined at random.
[2]Naugatuck Chemicals, Division of Dominion Rubber Company, Limited, Elmira, Ont.
[3]Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.

It was feared that the use of DDT for the control of *Lygus* bugs in British Columbia peach orchards might result in an increase of phytophagous mites. To date, there has been no evidence that this has occurred, either in experimental or in grower-sprayed orchards.

## Summary

Experiments conducted in British Columbia peach orchards from 1947 to 1952 indicated that the number of peach fruits injured by *Lygus* bugs was appreciably reduced by spraying the trees with DDT. Best results were obtained with a mixture of DDT, stove oil, and Velsicol AR-50 applied at 90 per cent petal-fall and again at 90 per cent shuck-fall. A single spray at petal-fall was almost as effective, and, on the basis of cost, the second application was not justified. Injury to fruit was also reduced by spraying with a mixture of BHC, stove oil, and Velsicol AR-50 at 95 per cent petal-fall and again at 95 per cent shuck-fall. Parathion at the petal-fall stage was slightly more effective than DDT at the same stage; work with parathion was discontinued, however, because of its extreme toxicity to man.

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**Mallis, Arnold. 1954.** *Handbook of Pest Control* (2nd Ed.) **MacNair-Dorland Co., New York. Illus., pp. 1068**

This is a valuable reference book, handsome, well-bound and printed on good paper. Frankly aimed at pest control operators, it will nonetheless prove useful to anyone likely to be consulted about household or industrial pests. Its worth is attested by the fact that it is in a second edition after nine years.

Obviously it is not possible to pass judgment on the hundreds of control methods culled from papers, so that discussion must centre on the arrangement and presentation. Here the book is open to criticism. More condensation, and judicious pruning of long quotations would help to avoid redundancies such as this: of poisoned rats, Mallis quotes: "Of course, the odor can be quickly abated if the dead animal is found and removed" (p. 94).

A useful addition, whether or not the reader were familiar with insects, would be master keys after the style of Metcalf and Flint, so that a completely unfamiliar pest could be tracked down quickly. The breakdown might be according to habitat, food, size, shape or Order. Already there are several very good, short keys in the text, giving distinctions within groups. The arrangement of sub-heads within chapters is not uniform, but an adequate index partly compensates for this lack. Each chapter ends with a good bibliography. The style is breezy and even colloquial.—*H. R. MacCarthy.*

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# SOME FACTORS REDUCING CARROT SEED YIELDS IN BRITISH COLUMBIA[1]

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Commercial production of carrot seed in Canada is confined to British Columbia and most of it has for many years been grown at Grand Forks. In earlier years good yields were obtained, growers had little or no difficulty with pests or diseases, and returns were satisfactory. During the Second World War, when seed could not be imported, acreage was greatly increased to meet domestic needs. With the increase in acreage over a period of years, certain insects and diseases increased to such an extent that they caused serious damage to crops. Since the war, production has declined because of (1) the availability of imported seed at competitive prices and (2) the marked reduction in yields resulting from damage by insects, diseases, and some other factors. Although imported seed has to a considerable extent replaced home-grown seed it is considered that domestic production can still be profitable if satisfactory yields can be obtained. This paper deals with the chief factors in reduced yields in recent years.

## Insect Pests

During 1947 and 1948 heavy infestations of a plant bug caused severe reductions in carrot seed yields at Grand Forks (Handford, 1949). At that time the insect was identified by the Taxonomic Unit, Ottawa, as *Lygus campestris* (L.), a European species recorded by Knight (1917, 1941) as widely distributed in North America and a pest of celery in Eastern Canada. (Brittain 1918) recorded this species as injurious to parsnip seed in Nova Scotia, and Matthewman (1941) reported damage by it to celery in Ontario. The bug is recorded by Alexander (1943) and by Whitcomb (1953) as a pest of celery in Massachusetts. Parshley (1919, 1921) refers to it as having been taken in the interior of British Columbia during 1917, but it had not been known as a crop pest in the province until 1947. In 1952 specimens of the bug from infested carrot seed fields at Grand Forks were identified by Mr. L. A. Kelton (in litt.), Entomology Division, Ottawa, as of a Nearctic species, *L. scutellatus* (Uhl.), the identity of which had been established by Wagner and Slater (1952). There is now much doubt that *L. campestris* occurs in North America. It is very likely that the earlier records concerned *scutellatus*. Strickland (1953) has recorded *scutellatus* from various localities of southern Alberta.

Subsequent study by the author showed that *L. scutellatus* is widely distributed in the southern interior of British Columbia, where it normally breeds on wild unbelliferous plants such as cow parsnip (*Heracleum lanatum* Michx.), water hemlock (*Cicuta douglasii* Coult. and Rose), and hemlock water parsnip (*Sium cicutaefolium* Schrank.). The bug was also found infesting seed plants of parsnip and dill at Grand Forks, but seed damage was negligible. Infestations have occurred annually in seed crops at Grand Forks since 1947 but none have been observed elsewhere except in one field at Armstrong in 1949 (Handford and Neilson, 1949). The insect has not been found damaging carrot root crops, the only case of infestation so far observed being a single adult taken in a field at Armstrong during 1953 by Dr. R. H. Handford, Officer-in-Charge of the Kamloops laboratory.

Experiments conducted by Handford (1949) demonstrated that *L. scutellatus* could be controlled with DDT and the seed yield doubled as a result. The outbreak subsided in 1949 and since then no significant damage has

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**TABLE I.—Effects of Diseases on Germination and Yield of Carrot Seed, Grand Forks. B.C., 1952 and 1953.**

| Field | Percentage of growing plants affected by Blight | Percentage of growing plants affected by Black rot | Percentage of plants killed by root rots early in season | Germination % | Seed yield lb. per acre |
|---|---|---|---|---|---|
| Starchuck, 1952 | 6 | 3 | trace | — | 1674 |
| Cutt, 1952 | trace | trace | trace | 85 | 764 |
| Cutt, 1953 | 0 | 2 | 3 | 71 | 821 |
| Moore, 1953[1] | 2 | 3 | 8 | 78 | 780 |
| Moore, 1952 | 10 | 4 | 8 | — | 695 |
| Holobofl, 1953[1] | trace | 5 | 9 | 80 | 634 |
| Abrosimoff, 1952 | trace | 5 | 30 | 85 | 614 |
| Semenoff, 1952 | 4 | 3 | 32 | 87 | 597 |
| Big-Y, 1952 | 15 | 8 | 20 | 86 | 563 |
| Peterson, 1952 | trace | 4 | 41 | 87 | 545 |
| Kazakoff, 1952 | 77 | trace | trace | 85 | 527 |
| Semenoff, 1953 | trace | 10 | 25 | 84 | 320 |
| Wirischagin, 1952[2] | 76 | many | trace | 86 | 242 |
| Samsonoff, 1952[1] | 2 | 25 | 3 | 88 | 110 |

[1]Part of crop damaged by wireworms.
[2]Crop severely infected with aster yellows virus.

been caused by this species in British Columbia. As the insect is a native species established on wild host plants throughout the southern interior of the Province, it is reasonable to assume that outbreaks may occur again.

Surveys made by the author at Grand Forks during 1951 and 1952 showed that many kinds of insects frequent carrot seed crops, most of them being harmless. Some are beneficial as crop pollinators or as predators of injurious species. However, several kinds that might be injurious were present in most fields. These included springtails, thrips, aphids, leafhoppers, wireworms, grasshoppers, and various plant bugs, including several other species of *Lygus* than *L. scutellatus*. Large numbers of springtails, thrips, and leafhoppers were found in some crops but they appeared to cause no serious damage. Populations of grasshoppers and plant bugs other than *L. scutellatus* have been very small and injury by them has been insignificant. Most crops are infested annually by small numbers of *Lygus elisus* Van. D., *L. lineolaris* P. de B., *L. atriflavus* Kgt., and *L. schulli* Kgt. In 1950 Dr. H. R. MacCarthy (unpublished), of the Kamloops laboratory, carried out an experiment at Grand Forks with adults of the *L. elisus-lineolaris* group by caging them on umbels in various stages of bloom and seed development. He found that 10 bugs feeding on umbels in the late-bloom stage for 10 days caused a marked reduction in seed yield but that at other stages of growth seed yield was not affected significantly.

Since the outbreak of *L. scutellatus* during 1947 and 1948, the only noticeable insect damage at Grand Forks has been caused by the Pacific Coast wireworm, *Limonius canus* Lec. Parts of one or two fields during each of the last three years have been infested. The wireworms attack roots soon after planting, so that many plants are killed early in the season or become so damaged that no bloom or seed develops.

## Diseases

After the insect outbreaks of 1947 and 1948 crops generally improved but some growers still obtain yields much below average. In the absence of serious insect damage, observations were made to determine what other factors might be responsible. During 1948 Handford (1949) observed that in some fields many plants died within a few weeks after planting, the roots having rotted completely. In 1950 Dr. MacCarthy (unpublished) observed that many plants in some fields showed symptoms of infection by a bacterial blight and that loss of plants from root rots ranged from 6 to 27 per cent. In 1951 the author observed similar infection of growing plants and that considerable plant loss resulted from root rots. In some badly infected fields, areas from 10 to 30 feet in diameter were devoid of plants and blank spaces of 2 to 20 feet along rows were common. Further study during 1952 and 1953 showed that diseases were the chief cause of marked reductions in yield.

Root rots are responsible for most of the plant loss from disease. Many infected roots rot completely soon after planting. Much of the loss is primarily due to black rot, caused by *Stemphylium radicinum* (Meier, Drechsl., and Eddy) Neerg. Roots may have only slight or incipient infection when planted in the field, but later rot so extensively that the roots wither and die before seed matures properly. Other rots are caused by *Sclerotinia scleratiorum* (Lib.) de Bary, *Botrytis cineria* Pers., and *Fusarium spp.* Bacterial rots, probably due mostly to *Erwinia carotovora* (L. R. Jones) Holland, also occur, and these frequently act as secondary rots following initial damage by the black rot organism. Fields surveyed by the author during 1952 and 1953 showed that root rots reduced some crop stands as much as 40 per cent.

Two other diseases that attack carrot seed crops are a bacterial blight, *Xanthomonas carotae* (Kendr.) Dowson, and yellows, caused by the aster yellows virus. The bacterial blight may affect the whole plant or only part, causing severe damage to plant tissues. Frequently complete or partial blasting of umbels by this blight destroys bloom and seed. Although blight has been common, it has not been severe enough at Grand Forks to seriously affect total crop yields.

Occurrence of the yellows disease is sporadic in some fields but in others it may be abundant, as in one field during 1952, when the entire crop developed a yellowish colour. The umbels were much smaller than normal. Many flowers became infertile due to imperfect formation. Yield from this field amounted to only 242 pounds of seed per acre compared with the average of 600 pounds. This disease is spread by a leafhopper during its feeding on plants and primary infection usually occurs the first year on steckling plants.

The effects of the diseases on seed production are shown in Table I. Crops with least infection produced the highest yields. The poorest yields were obtained from those crops severely infected with root rots. Although the diseases caused serious reductions in seed yields, they apparently had no adverse effect on germination, percentage germination of seed from badly infected crops being as high as that of seed from the least infected ones.

There are other factors that also tend to reduce yields. Low soil fertility, careless cultivation, and improper crop management, especially at planting and harvest, result in a certain amount of seed loss yearly, and no doubt these factors account for the variations within the infected and relatively uninfected crops.

## Summary

Bacterial blight, black rot, several other species of root rot, and aster yellows virus damage carrot seed crops at Grand Forks, British Columbia. Black rot and the other root rots are responsible for most of the damage, and since 1948 these diseases have been the chief cause of serious reduction in seed yields. A native plant bug, *Lygus scutellatus* Uhler, caused severe reductions in yield during 1947 and 1948. It has not been a serious pest since that time but it is common and widely distributed throughout the southern interior of British Columbia, where it breeds on several wild species of Umbelliferae as

well as on seed crops of parsnip and dill; hence it may be assumed that outbreaks may occur again. Other species of *Lygus* have proved capable of reducing seed yields under caged conditions, but outbreaks have not occurred in carrot seed crops in British Columbia. Sporadic infestations of the Pacific Coast wireworm have occurred in some crops, but damage has not been serious. Other injurious insects infest carrot seed crops, but they have not caused serious damage at Grand Forks.

## Acknowledgments

The author is indebted to Dr. R. H. Handford, Officer-in-Charge of the Kamloops laboratory, for data on the insect outbreaks of 1947 and 1948 and on control of the bug *L. scutellatus.* Data for 1950 on insect infestations, prevalence of disease, and damage done by bugs of the *L. lineolaris-elisus* group were kindly provided by Dr. H. R. MacCarthy of the Kamloops laboratory. For identification and appraisal of diseases attacking carrot seed crops, the author gratefully acknowledges the assistance of Mr. G. E. Woolliams, Associate Plant Pathologist, Plant Pathology Laboratory, Summerland, B.C. Wild host plants on which *L. scutellatus* breeds in the southern interior of British Columbia were kindly identified by Dr. T. M. C. Taylor, Head, Department of Botany, University of British Columbia, and Messrs, W. L. Pringle and A. McLean, Dominion Range Experiment Station, Experimental Farms Service, Kamloops, B.C.

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## House Fly Maggots Infesting a Child's Bed

In October 1952, a public health inspector brought in from North Vancouver, some very small maggots which had been removed from the surface and from inside the fabric of a mattress of a child's bed.

The inspector said that a similar infestation had occurred earlier that season on an expensive mattress recently purchased with a new bed. The owners had contacted the store from which the bed had been purchased and they and the manager of the store and the health inspector, had shredded the mattress and found many maggots and puparia inside the stuffing. The store then replaced the mattress and shortly afterwards, more maggots were found in the new one. As usual in such cases, the people concerned considered they had done the right thing by drenching the mattress, the bed and the room, with insecticide. However, the inspector saved six maggots to bring to me. Three of these died shortly afterwards, but three pupated and between November 14 and November 18, three flies emerged which I identified as *Musca domestica* Linn. the common house fly. The flies were scarcely half the size of normal house flies so I sent one to Mr. G. E. Shewell, Division of Entomology, Ottawa, who confirmed my identification.

The inspector said that the house where the infestation occurred was right on the sea shore, belonged to people of some substance, was extremely clean and well kept and that the housewife declared that the baby's bed was always covered with a rubber sheet under the normal bed clothes. Probably the rubber sheet leaked and the mattress became soaked with urine, and when it was hung out to dry, the flies laid eggs upon it; certainly a diet of urine was famine rations because the maggots were half starved and stunted and the flies were the smallest I have ever seen of this species.

Amongst a long list of substances on which or in which house fly maggots can develop Hewitt* records "substances contaminated or mixed with excremental products, such as bedding from piggeries and from rabbits and guinea pigs, paper and textile fabrics which have been contaminated, as cotton and woollen garments, sacking, rotten flock-beds, straw mattresses, cess pools, etc.", but he does not mention urine-soaked material specifically, *i.e.,* material contaminated with urine only. (There *is* a recent reference to house flies developing on urine alone but I cannot locate it at this time.—*G. J. Spencer, University of British Columbia.*

* Hewitt C. Gordon, 1910. The House Fly. Manchester University Press.

## SOME UNUSUAL RECORDS OF BEETLES IN VANCOUVER

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Two blocks from my house in West Point Grey are several rhododendron bushes whose lower leaves have been ragged for years. On May 20, 1952, I examined them at night with a flashlight, swept the bushes thoroughly and recovered a few specimens of *Brachyrhinus singularis* L. the clay-coloured weevil which injures laurel hedges so extensively in Vancouver, but more specimens of a weevil identified for me as *Strophosoma melanogrammus* Forst, an insect slightly smaller than the clay-coloured weevil. In his Catalogue of the Coleoptera of North America Leng lists one species (16641) in this genus, *S. coryli* (Fab.); I do not know when Forst named this second species. Andison (Proc. B.C. Ent. Soc. 38, 1942) mentions that Kaven in Germany found *B. singularis* attacking rhododendron, but this instance of *S. melanogrammus* would seem to be a new record for this species on this host.

Another unusual record is of a small bettle *Barypeithes pellucidus* Boh., No. 16672 in Leng's Catalogue, the only species in this genus, listed as "introduced" from Old France and recorded from New England and New York. This beetle was sent in to me from Burnaby where it was found in tunnels of one of our native death watch beetles *Coelosthetus* which was burrowing freely in timbers of an old house, heavily attacked by dry rot. Chunks of wood were sent to me (25.V.1953) and I recovered the beetles from the tunnels. This was the second time that I have taken this beetle from tunnels of *Coelosthetus*; but the first time I mistook them for strawberry root weevils that had merely sheltered in the wood and, unfortunately I discarded them. The insects which are slightly smaller than the strawberry root weevil, have a shining black head with very dark brown thorax, dark brown elytra and tan-coloured legs and antennae. It may be that this beetle is a predator on some stage of *Coelosthetus*; its occurrence in the death watch tunnels seems to be hardly accidental.

A third rather unusual beetle record is of a small Nitidulid, *Meligethes nigrescens* Stephens, not mentioned in Leng's Catalogue. Specimens of this insect were brought to me in April, 1953, from a neighbouring golf course where they alighted in such numbers on the surface of a pail of water that a groundsman was carrying, as to excite his astonishment and curiosity. On the 10th of May, 1953, I collected several scores of this same beetle from the shady side of an empty concrete swimming pool at Milner in the Fraser Valley. Moisture was condensing on the side of the pool and the beetles confined themselves to the wet areas; if one moved on to a dry patch, it soon came back to the wet surface. The sides of the pool were vertical and, from somewhere, hundreds of these insects arrived, but alighted only on the damp areas. I am deeply indebted to Hugh B. Leech for the preceding three identifications.

Finally, on March 4th, 1954, a couple brought me some beetles which, they said, were continually appearing in their bath tub; they wondered if they were of economic importance. The small beetles are *Cryptophagus bidentatus* Makl., recorded from Alaska, of which I have one specimen taken from the fur of a Shrew at Alta Lake; however, *bidentatus* has very small ommatidia in its eyes and these specimens have larger, rather projecting ommatidia; otherwise they are very similar. I promptly asked the people if they had any polypore fungi in the house and, as it turned out, he is a school teacher who collects fungi so these beetles must have come from one of his specimens.

In the bath tub was also a larger 5½ mm. beetle which keys out in Hinton's monograph to the genus *Megatoma,* family Dermestidae. Leng calls the genus *Perimegatoma,* but Hinton states that the genotype of *Perimegatoma* cannot be distinguished from the genotype of *Megatoma* so the latter name has priority. Of this genus I have only two species at the University: *P. cylindrica* Kirby which is a synonym of *P. falsa* Horn, and *P. vespulae* Milliron which is proving a pest of the first magnitude in the departments of Zoology and Botany at the University where it attacks insect material in our cabinets and the plants in the herbarium.

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# SOME RECORDS OF ECTOPARASITES FROM FLYING SQUIRRELS

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From a number of records on hand of ectoparasites from flying squirrels, I have selected only those instances in which I picked off the specimens myself by a uniform system of combing, brushing and laboriously examining under a low power microscope in order to obtain the greatest number of specimens without resorting to the Werneck-Hopkins method of dissolving the fur in hot caustic soda.

The same procedure is followed when examining birds and mammals, namely, parting the fur on the neck and head under a stereoscopic microscope to find an egg or a louse as an indication of infestation, and, if either is present, combing the head and neck first and then the whole body with a medium, then a fine-toothed comb and brushing in all directions over a large sheet of white paper with a stiff test-tube brush. Short-haired mammals or birds with short feathers on neck and head are subjected also to a rapidly rotating round brush twirled by a machine. Every animal is examined both as soon as received and again, after being held overnight in a refrigerator at 18° F. to either kill or stiffen any lice which would not release their hold under the first treatment.

The local flying squirrel *Glaucomys sabrinus oregonensis* (Bachman) is fairly common in the woods on the campus

**Some records of Ectoparasites from Flying Squirrels**

| | VANCOUVER | | | | | Alta. |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| | 1 Nov. 1954 (per cat) | 15 Nov. 1954 (per cat) | 11 July 1955 Trapped | 12 Aug. 1955 Trapped | 12 Aug. 1955 Trapped | Alberta 1947 |
| **Sucking lice** | | | | | | |
| *Microphthirus uncinatus* (Ferris) | 39 | 180 | 4 | | 4 | 5 |
| *Neohaematopinus sciuropteri* (Osborn) | 13 | 127 | 19 | 16 | 28 | 3 |
| *Hoplopleura trispinosa* Kell. & Ferris | | 70 | 6 | 3 | 7 | 8 |
| **Fleas** | | | | | | |
| *Opisodasys vesperalis* (Jordan) | | 16m. 21f. | 4 | | 2 | |
| *Monopsyllus ciliatus protinus* Jordan | | 1 | | | | |
| **Ticks** | | | | | | |
| *Ixodes pacificus* Cooley | | 1 | | | | |
| **Mites** | | | | | | |
| Spp. undetermined | | 10 3spp. | 13 | 1 | 6 | |

In the table above, specimens A and B were captured by the cat of President M. M. McKenzie which chewed off the head of specimen B before the squirrel could be taken from it. The finding on squirrel A of *Microphthirus uncinatus* (Ferris) constitutes, as far as I can find out from literature, the second record for this louse which Ferris named in 1919 as the genotype of a new monotypic genus. Ferris says "This is a very peculiar form, known only from North American flying squirrels of the genus *Glaucomys*. . . . known only from the original record from *Glaucomys sabrinus* at Yosemite National Park, California . . . This is one of the very smallest of all sucking lice, the male attaining a length of only about 0.35 mm. The insects are so small that as seen upon their host they are very likely to be mistaken for young of one of the other species which occur on these squirrels".

Specimen B would very probably have had a still higher parasite count if it could have been examined while the head was attached. As it is, the population present was the ultimate, almost the incredible, ever recorded from this host and certainly in record numbers. Apart from the huge populations of three species of lice, the numbers of the flea *Opidasys vesperalis* (Jordan) namely 16 males and 21 females, also seem to be a record and a considerable number may very well have ascaped in the course of the rough handling the squirrel got before it fell into my hands.

Specimen D was the only one of the six recorded here, to have no *M. uncinatus* on it and specimen E was unusual in that the hairs of the back half, above the hind legs, were plastered with louse eggs that had hatched but the young had not survived. This was an unusual location for louse eggs which are almost invariably attached on top of the head or around the neck. Of the three species of lice, *H. trispinosa* occurred all over the body but the other two species did not overlap; especially on specimen B *M. uncinatus* was entirely dorsal over the shoulder blades and *N. sciuropteri* entirely ventral across the sternum. All three species of lice are specific to flying squirrels.

Specimen F from Alberta, is included here because it was sent in as a whole animal, not merely as a skin, and I was able to work it over myself. Its main interest is that it harboured Ferris' minute species *uncinatus* which seems widespread in more northern flying squirrels.

**References**

Ferris, G. F. Contributions Towards a Monograph of the Sucking Lice, Part I: 49; Figs. 31-32. 1919.

Ferris, G. F. The Sucking Lice, Memoirs Pacific Coast Ent. Soc., Vol I, p. 115; Figs. 50, 51. Cal. Acad. Sc., San Francisco 18, Cal. 1951.

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## LIST OF INSECTS AND MITES ATTACKING TREE FRUITS IN THE INTERIOR OF BRITISH COLUMBIA[1]

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This is the first published list of insects and mites that attack tree fruits in the interior of British Columbia. It includes only the species that have caused economic loss. Although some of them are but sporadically injurious, none are merely occasional or incidental feeders. An E in the host columns designates the pest as one of major economic importance against which control measures must be frequently taken; an S indicates that it is only sporadically injurious.

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2. Assistant Entomologist.
3 Associate Entomologist.

| Species | Apple | Apricot | Peach | Pear | Plum and Prune | Cherry |
|---|---|---|---|---|---|---|
| Acrididae, grasshoppers, various species | | E | S | S | S | S |
| *Anarsia lineatella* Zell., peach twig borer | | E | E | | E | |
| *Anisandrus pyri* (Peck), pear blight beetle | | | S | | | S |
| *Anthophila pariana* (Clerck), apple and thorn skeletonizer | S | | | | | |
| *Anuraphis bakeri* (Cowen), clover aphid | S | | | | S | |
| *Anuraphis cardui* (L.), thistle aphid | | E | | | E | |
| *Anuraphis persicae-niger* (Smith), black peach aphid | | | E | | | |
| *Anuraphis roseus* Baker, rosy apple aphid | E | | | | | |
| *Aphis pomi* Deg., apple aphid | E | | | S | | |
| *Archips argyrospila* (Wlkr.), fruit tree leaf roller | E | E | | E | S | E |
| *Archips cerasivorana* (Fitch), ugly nest caterpillar | | | | | | S |
| *Archips rosaceana* (Harr.), oblique-banded leaf roller | S | S | S | S | S | S |
| *Aspidiotus ostreaeformis* Curt., European fruit scale | E | | | | E | S |
| *Aspidiotus perniciosus* Comst., San Jose scale | E | E | | E | E | E |
| *Bryobia praetiosa* Koch, clover mite | E | S | S | S | E | S |
| *Caliroa cerasi* (L.), pear-slug | | | | E | S | E |
| *Carpocapsa pomonella* (L.), codling moth | E | S | S | E | S | S |
| Cicadidae, cicadas, various species | S | | | | E | S |
| *Coleophora cerasivorella* Pack. (= *C. occidentis* Zell.), cigar casebearer | S | | | | | |
| *Coleophora pruniella* Clem., cherry casebearer | E | | | S | | E |
| *Corythucha padi* Drake, choke cherry tingid | | | | | | S |
| *Cyphoderris monstrosa* Uhler, a cricket | S | | S | | | |
| *Datana ministra* (Drury), yellow-necked caterpillar | E | S | | S | S | S |
| *Diptacus gigantorhynchus* (Nal.), big-beaked plum mite | | | S | | S | S |
| *Edwardsiana rosae* (L.), rose leafhopper | E | | | | E | E |
| *Empoasca maligna* (Walsh), apple leafhopper | S | | | | | S |

| Species | Apple | Apricot | Peach | Pear | Plum and Prune | Cherry |
|---|---|---|---|---|---|---|
| *Eotetranychus carpini borealis* (Ewing), yellow spider mite | E | | | | | |
| *Epitrimerus pyri* (Nal.), pear rust mite | S | | | | | |
| *Eriophyes pyri* (Pgst.), pear leaf blister mite | E | | | E | | |
| *Eriosoma lanigerum* (Hausm.), woolly apple aphid | E | | | | | |
| *Erythroneura* spp., leafhoppers | | | | | | S |
| *Estigmene acrea* (Drury), salt-marsh caterpillar | S | | | | | |
| *Forficula auricularia* L., European earwig | | S | S | | | S |
| *Frankliniella occidentalis* (Pergande), western thrip | E | | | | | |
| *Grapholitha packardi* (Zell.), cherry fruitworm | | | | | | E |
| *Grapholitha prunivora* (Walsh), lesser appleworm | S | | | | | |
| *Hyalopterus arundinis* (F.), mealy plum aphid | | E | | | E | |
| *Hyphantria cunea* (Drury) fall webworm | S | | S | | | S |
| *Incisalia iroides* (Bdv.), western elfin | S | | | | | |
| *Lecanium* spp., scales | S | E | S | | S | |
| *Lepidosaphes ulmi* (L.), oystershell scale | E | S | S | S | S | S |
| *Limonius discoideus* Lec., a click beetle | | | | | S | |
| *Lygus* spp., plant bugs | E | | E | E | | |
| *Malacosoma disstria* Hbn., forest tent caterpillar | E | | | S | S | S |
| *Malacosoma pluviale* (Dyar), western tent caterpillar | E | | | S | | S |
| *Marmara pomonella* Busck, apple fruit miner | S | | | | | |
| *Metatetranychus ulmi* (Koch), European red mite | E | S | E | E | E | E |
| *Mineola scitulella* Hulst, Mineola moth | S | | | | | |
| *Myzus cerasi* (F.), black cherry aphid | | | | | | E |
| *Myzus persicae* (Sulz.), green peach aphid | | S | E | | S | S |
| *Oecanthus* sp., a tree cricket | S | | | | | |
| *Operophtera bruceata* (Hulst), Bruce spanworm | S | | | | | |
| *Phalaenidae,* cut worms, various species | E | E | E | E | S | S |
| *Phenacoccus aceris* (Sign.), apple mealybug | E | | | S | S | S |
| *Phorodon humuli* (Schr.), hop aphid | | | | | S | |
| *Phyllocoptes abaenus* K., a rust mite | | | | | S | |
| *Pristiphora californica* (Marl.), California pear-slug | | | | S | | |
| *Psylla pyricola* Foerst., pear psylla | | | | E | | |
| *Pulvinaria* sp., a scale | | S | E | | S | |
| *Rhagoletis fausta* (O.S.), black cherry fruit fly | | | | | | E |
| *Rhopalosiphum prunifoliae* (Fitch), apple grain aphid | E | | | | | |
| *Sanninoidea exitiosa exitiosa* (Say), peach tree borer | | E | E | | E | |
| *Schizura concinna* (A. & S.), red-humped caterpillar | S | S | | S | S | S |
| *Spilonota ocellana* (D. & S.), eye-spotted bud moth | E | S | S | E | E | E |
| *Stictocephala basalis* (Walk.), a treehopper | E | | | | | |
| *Stictocephala bubalus* (F.), buffalo treehopper | E | E | E | E | E | S |
| *Taeniothrips inconsequens* (Uzel), pear thrips | | | | E | S | S |
| *Tetranychus mcdanieli* McG., a spider mite | S | | | | | |
| *Tetranychus pacificus* McG., Pacific spider mite | S | | S | S | S | S |
| *Tetranychus telarius* (L.), (=*bimaculatus* Harvey), two-spotted spider mite | E | S | E | S | E | E |
| *Tetranychus urticae* (Koch), a spider mite | S | | | | S | |
| *Torymus druparum* Boh., apple seed chalcid | S | | | | | |
| *Typhlocyba pomaria* McA., white apple leafhopper | E | | | | E | S |
| *Vasates cornutus* (Banks), peach silver mite | | | E | | | |
| *Vasates* (*Phyllocoptes*) *fockeui* (Nal. & Trt.), plum nursery mite | | | | | S | E |
| *Vasates* (*Phyllocoptes*) *schlechtendali* (Nal.), apple rust mite | E | | | S | E | |
| *Xyleborus saxeseni* (Ratz.), a shot-hole borer | | | S | | | |

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART III— *EUPITHECIA* SPP. (GEOMETRIDAE)[1]

D. A. ROSS[2] AND D. EVANS[3]

About 35 species of *Eupithecia* live on forest trees and shrubs in British Columbia. With the exception of *E. albicapitata* and *E. columbrata,* the local *Eupithecia* are defoliators: half the species of defoliators are conifer feeders; the others feed on broad-leaved trees. Several of the species are common although none has been observed to cause noticeable defoliation.

*Eupithecia* larvae are small slender loopers usually about 1 inch in length. The body is yellowish, brownish, or green; the majority of species have a dark dorsal line or stripe, occasionally subdorsal stripes. Others, *e.g.,* cedar and juniper feeders, have markings that resemble the foliage. Under high magnification, the larval skin appears to have a pebbly texture. The larvae of many British Columbia species are poorly known; only a few of the commonest ones are described in this paper.

All *Eupithecia* listed here overwinter in the pupal stage, excepting *E. bryanti, E. niphadophilata, E. unicolor,* and *E. graefii* which, presumably, hibernate in the larval or egg stage.

The species below are arranged in alphabetical order for convenience.

**E. albicaptitata** Pack. *Picea* glauca (cones and *Adelges* galls), *P. engelmanni* (cones); Interior B.C. and Whitehorse, Yukon Territory. **Larva:** Body flesh coloured, with reddish stripes.

**E. annulata** (Hlst.). *Pseudotysuga taxifolia, Picea engelmanni, P. glauca, Abies lasiocarpa, A. grandis, A. amabilis* (3 records), *Tsuga heterophylla, T. mertensiana* (1). Central Interior, Southern B.C. and V.I.†; a very common species. **Larva:** $\frac{7}{8}$ inch; head, pale brown; body reddish-brown or yellowish-brown; brown dorsal line, double on thorax; faint cream subdorsal stripe may be present; supraspiracular area reddish-brown; subspiracular fold cream; centre of suranal plate concolorous with head, edge cream-coloured.

**E. arceuthata** (Freyer). *Juniperus communis,* Fintry, Quesnel; *J. scopulorum,* Golden, Narcosli Creek. **Larva:** head and body, green; dark dorsal and supraspiracular stripes; spiracular line greenish-yellow.

**E. bryanti** Tayl. *Salix* sp., Saturna Island. Larva collected May 20, pupated May 22, adult emerged June 15.

**E. castigata** (Hbn.). *Alnus rubra* (1), Upper Pitt River, Pitt River, Buntzen Lake; *Populus balsamifera* (1), Mile 20, Alaska Highway. **Larva:** creamy-brown ground colour, dark brown markings on the dorsum.

**E. columbiata columbiata** (Dyar). *Salix* spp., Mabel Lake; *Alnus* spp., Trinity Valley, Lillooet River; *Betula* sp., Quesnel, Queens Bay; *Acer glabrum,* Creston. **Larva:** brownish-red, with dark lines on dorsum.

**E. columbiata holbergata** MacK. *Alnus* spp., *Salix* sp., *Rhamnus purshiana,* Southern Coast and V.I. **Larva:** reddish-brown body; vague lines on dorsum; broken dark subdorsal stripe; short anal tubercles.

**E. columbrata** McD. *Picea sitchensis* (cones); Southern Coast and V.I. **Larva:** pale orange-brown, shaded darker on the dorsum.

**E. filmata** Pears. *Picea engelmanni, P. glauca, P. mariana, P. sitchensis, Abies lasiocarpa* (1 record); Central and Southern Interior, and Northern Coast. **Larva:** head, pale brown; body pale brown with dark brown markings; brown pattern on dorsum extending to sides of body about each abdominal spiracle; broken dark brown subdorsal line; subspiracular stripe cream-coloured. This pattern may be obscure on some specimens.

**E. fletcherata** Tayl. *Alnus* sp., Dashwood V.I. **Larva:** pale brown, dark brown "diamond" pattern on dorsum.

**E. gelidata** Moeschler. Mile 1184, Alaska Highway, Y.T.

**E. georgii** McD. *Betula papyrifera* (1 record), *Ceanothus* sp. (1); Enderby, Falkland, Armstrong, Squilax. **Larva:** "pale brown; double dorsal line expanding into diamond pattern."

**E. gibsonata** Tayl. *Thuja plicata*; Minnette Bay, Terrace.

**E. graefii vancouverata** (Tayl.). *Arbutus menziesii, Thuja plicata* (1), *Pseudotsuga taxifolia* (1); V.I. Pupates in July, adult emerges August. **Larva:** variable yellow-green; reddish dorsal stripe onto vertex of head; reddish spiracular line sometimes present.

**E. harrisonata** MacK. *Tsuga heterophylla, Abies amabilis* (5), *A. grandis* (4), *A. lasiocarpa* (1), *Pseudotsuga taxifolia* (4), *Picea glauca* (3); Southern Coast and V.I. **Larva:** apparently there are two colour phases: one is a

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† Vancouver Island.

velvety green; the other is reddish-brown. Both phases have a dark dorsal line with pale edging; fine dark subdorsal lines, yellowish subspiracular lines; dark venter, usually with light subventral lines.

**E. kananaskata** MacK. *Alnus* sp. (1 record); Vedder; (Kaslo and Chilliwack - MacKay 1951). **Larva:** "dorsum has long diamond markings."

**E. longipalpata** Pack. *Tsuga heterophylla, T. mertensiana* (1), *Pseudotsuga taxifolia, Abies grandis* (3), *Picea sitchensis* (2), *Pinus monticola* (1), *Pinus contorta* (1), *Thuja plicata* (1); V.I., Queen Charlotte Islands, Southern and Central Coast. **Larva:** "head and body yellowish-green; dark dorsal line; pale subdorsal lines sometimes present; yellowish spiracular line."

**E. luteata bifasciata** (Dyar). *Pseudotsuga taxifolia, Picea engelmanni, P. sitchensis, P. mariana* (1), *Abies lasiocarpa, A. amabilis, A. grandis* (2), *Larix occidentalis, L. laricina, Tsuga heterophylla, Pinus contorta* (1), *P. monticola* (2); Central and Southern B.C. and V.I. This is one of the most abundant of the forest *Eupithecia.* **Larva:** ground colour variable — may be yellowish-green, brownish, orange or reddish; dark dorsal line, may be broken; light brown subdorsal lines; suranal plate usually tipped red; dark venter, with light subventral lines.

**E. maestosa harlequinaria** (Dyar). *Alnus* spp., *Arbutus menziesii* (3), *Prunus* **sp.** (1), *Salix* sp. (1), *Quercus garryana* (1); Southern Coast and V.I. **Larva:** head and body, pale green; reddish dorsal stripe.

**E. maestosa maestosa** (Hlst). *Alnus* sp., Athalmer. Larvae taken during July pupated in August. **Larva:** "greenish-yellow".

**E. misturata misturata** (Hlst). *Rhamnus purshiana, Malus* spp.; Southern Coast and V.I. **Larva:** body. pale green, darker at terminals; darker dorsal and subdorsal lines; yellowish spiracular line.

**E. nimbicolor** (Hlst). *Salix* sp.; Miles 878 and 1202, Alaska Highway. **Larva:** "a pale yellow or cream".

**E. niphadophilata** (Dyar). *Juniperus communis,* Southern Interior; larvae taken May 24 - June 13, pupated in June and July; adults emerged in August. **Larva:** head pale greenish with brown blotches; body, green, black dorsal stripe; cream coloured spiracular area; brownish patch on suranal plate.

**E. olivacea** Tayl. *Pseudotsuga taxifolia, Tsuga heterophylla, Abies amabilis* (3), *A. grandis* (2); Southern Coast. **Larva:** head, pale brown; body yellowish-brown with darker diagonal markings along dorsum.

**E. ornata** (Hlst). *Pinus contorta, P. monticola* (1 record); Southern B.C. and V.I. **Larva:** 1 inch long; head, tan; body, light or yellowish-green; fairly bright red dorsal stripe edged with yellow; anal prolegs and anal tubercles reddish.

**E. palpata** Pack. *Pinus contorta, P. monticola P. ponderosa,* (3 records); Central and Southern Interior. **Larva:** pale tan head; greenish-yellow body, dark dorsal line, may be partially obscured by reddish or orange dorsum; yellowish spiracular stripe.

**E. perfusca** (Hlst.). *Betula papyrifera,* Enderby, Mara, Creighton Valley, Howe Sound. **Larva:** small tan head; body greenish-yellow; suranal plate reddish.

**E. perfusca kootenaiata** (Dyar). *Salix* sp., *Alnus* sp.. *Betula* sp. (1 record); Northern B.C., and Tagish and Whitehorse, Y.T. McDunnough (1949), gives the following distribution: "Fairly general in the south central region of British Columbia". **Larva:** "body yellowish with dark long diamond pattern on dorsum."

**E. placidata** Tayl. *Thuja plicata, Juniperus scopulorum*; Southern B.C. north to Alexandria in the Interior. **Larva:** resembles cedar or juniper twig. Head, tan; body, green; black or brown dorsal line, in form of a small U on the prothorax, and a chain of diamonds on the dorsum of the abdomen; a rusty brown patch on A4 and A5.

**E. pseudotsugata** MacK. *Pseudotsuga taxifolia, Picea glauca* (1 record); Southern Interior. **Larva:** "head, tan; body greenish or yellowish; reddish-brown dorsum with dark dorsal line." Apparently larvae of this species have been confused in the past with *E. ornata* and *E. palpata.*

**E. ravocostaliata** Pack. *Salix* sp.; Central and Southern Interior and V.I. **Larva:** head and body bright green; olive-green dorsal and subdorsal lines; yellow subspiracular line, edged below with red; red anal tubercles.

**E. rotundopuncta** Pack. *Salix* sp., *Picea sitchensis* (host?), Prince Rupert; Queen Charlotte Islands. **Larva:** head, brown; body, pale brown; broken brown lines on dorsum.

**E. satyrata** (Hbn.). *Salix* sp., Mile 1084 Alaska Highway; Carcross, Y.T.

**E. transcanadata** MacK. *Pseudotsuga taxifolia, Picea engelmanni, Tsuga heterophylla, Abies lasiocarpa, A. grandis, Thuja plicata, Larix occidentalis, L. laricina*; Central and Southern Interior, and West Prince Rupert Forest District. **Larva:** body, greenish; dark reddish dorsal line; fine dark subdorsal lines; larva very similar to *E. palpata.*

**E. unicolor** (Hlst.). *Thuja plicata, Pseudotsuga taxifolia, Tsuga heterophylla* (3), *Abies* spp., V.I.. Southern Coast. Larvae taken May 4 to July 12; pupae collected in latter half of July; adults emerged in insectary from June 18 to August 11. **Larva:** a twig mimic somewhat similar to *E. placidata*; "head reddish excepting the top, which is pale."

**E. usurpata** Pears. *Abies amabilis, A. grandis, Tsuga heterophylla* (1). *Thuja plicata* (1); V.I. and Southern Coast. **Larva:** head, bright tan; variegated brown diagonal pattern on body; irregular yellow spiracular line; dorsal and subdorsal lines at terminals.

**E. vinsullata** MacK. *Pseudotsuga taxifolia* Southern Interior. **Larva:** "body, pale brown or yellowish; dark dorsal line, fine lateral line; light spiracular line."

**Acknowledgments**

Most of the adults in our collection were identified by Miss M. R. MacKay, Entomology Division, Ottawa. Our relatively advanced stage of knowledge of this group is due to the interest that Miss MacKay took in *Eupithecia* while she was stationed at the Vernon laboratory.

Descriptions of larvae appearing in quotation marks were made by laboratory personnel other than the authors.

**References**

MacKay, M. R. Species of *Eupithecia* reared in the Forest Insect Survey in British Columbia. Canad. Ent. 83:77-91. 1951.

McDunnough, J. H. Revision of the North American species of the genus *Eupithecia*. Bull. Amer. Mus. Nat. Hist. 93(8):537-728. 1949.

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# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART IV—*HYDRIOMENA* SPP. (GEOMETRIDAE)[1]

D. A. ROSS[2] AND D. EVANS[3]

These loopers are considered to be of no economic importance since they occur in small numbers and have not been known to cause any appreciable defoliation. Of the 11 species noted here, 7 are conifer feeders; the others feed on broad-leaved hosts. The larvae of most species of *Hydriomena* are brownish; some species are banded, at least in the early instars.

*H. albimontanata, divisaria, irata, nubilofasciata,* and *renunciata* overwinter in the pupal stage; some, if not all of the other species overwinter in the larval stage.

**H. irata** Swett. All of our typical *irata* specimens came from *Picea sitchensis* on the Queen Charlotte Islands. McDunnough designated other series of specimens as "probably all forms of *H. irata*". The latter were reared from *Tsuga heterophylla, T. mertensiana, Pseudotsuga taxifolia,* and *Picea* sp. in various parts of British Columbia south of 54° latitude. **Larva:** pale brown head and suranal plate; early instars banded with reddish-brown or drab green; later instars with dark broken subdorsal and spiracular lines.

**H. marinata exasperata** B. & McD. *Pseudotsuga taxifolia,* Qualicum; *Abies grandis,* Sooke; *Picea sitchensis,* Knight Inlet. Pupation occurs in June; adults emerge late in June or early July.

**H.** probably **edenata grandis** B. & McD. *Pseudotsuga taxifolia,* Colwood on Vancouver Island. Larva pupated April 29; adult emerged in May.

**H. divisaria** Wlk. *Picea engelmanni, Pseudotsuga taxifolia, Abies lasiocarpa*; Central and Southern Interior.

**H. renunciata** Wlk. *Alnus* spp. Most of the specimens from V.I. and the Southern Coast are designated as *H. r. columbiata.* Other specimens from this area and Central and Southern Interior B.C. are designated as *H. renunciata.* Probably this is the commonest of the forest *Hydriomena* in B.C. **Larva:** head and prothoracic shield, brown; body, with purplish bands; pale double dorsal, wide subdorsal, and spiracular lines.

**H. albimontanata** McD. *Pseudotsuga taxifolia,* Southern Interior. **Larva:** head, tan; body, light brown, with a small dark brown patch on dorsum of each segment; small brown patches on sides of thorax.

**H. furcata** Borg. *Salix* spp. V.I. and Coast, and Central Interior. Pupation as early as June 11; first adult emergence date is July 13. **Larva:** 1 inch; very dark brown head and body; light subdorsal and spiracular lines; indistinct pale supraspiracular line.

**H. speciosata** Pack. *Pinus contorta, Pseudotsuga taxifolia, Tsuga heterophylla*; V.I. One specimen from *Abies Grandis,* Valdes Island, one from *Pseudotsuga taxifolia,* Salt Spring Island, and one from *Tsuga heterophylla,* Bute Inlet were designated as *H. s.* form *taylori*

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3 Forest Biology Laboratory, Victoria, B.C .

Swett. **Larva:** head, dark brown; body, pale brown, brighter on sides; dark irregular dorsal and "lateral" lines.

**H. morosata** B. & McD. *Pinus contorta,* Commotion Creek (near Moberly Lake).

**H. nubilofasciata** Pack. *Quercus garryana*; Victoria. **Larva:** complex linear pattern of bright variegated brown and grey.

**H. manzanita** Tayl. *Arbutus menziesii,* V.I. and Southern Coast. **Larva:** head and body greenish-yellow; fine greyish lines on dorsum.

**Reference**

McDunnough, J. H. 1954. The species of the genus *Hydriomena* occurring in America north of Mexico. Bull. Amer. Mus. Nat. Hist. 103(3):241-358.

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## AN ANNOTATED LIST OF THE COLEOPTERA TAKEN AT OR NEAR TERRACE, BRITISH COLUMBIA. PART 3.*†

M. E. CLARK

Masset, Queen Charlotte Islands, B.C.

*Melyridae*

**Dasytes** sp.
**Allonyx** sp.
**Eurelymis atra** LeC.—Taken in 1931; vide H. C. Fall.

*Cleridae*

**Thanasimus undatulus** Say—Det. by Wolcott.
**Thanasimus undatulus monticola** Wolc. — Det. Wolcott.
**Enoclerus sphegeus** Fab.—Scarce on spruce logs in June; vide A. B. Wolcott.

*Corynetidae*

**Necrobia violacea** Linn.—Rare; found in marrow bones, June and July.

*Cephaloidae*

**Cephaloon tenuicorne** LeC.—Rare.

*Oedemeridae*

**Calopus angustus** LeC.—From a yellow pine stump, April 1921; rare.
**Ditylus quadricollis** LeC.—Rare; taken by the creek, June 4, 1920.

*Mordellidae*

**Mordella borealis** LeC.—Frequent, from a yellowish-brown fungus on spruce logs, July to September; vide Liljeblad.
**Mordella marginata** Melsh.
**Anaspis rufa** Say—Common on red osier dogwood **(Cornus)**, and **Spiraea**, June and July.
**Anaspis atrata** Champ.—Verified by Liljeblad.
**Laricia nigricolor** Lilj.—A paratype from my material is in Mr. Frost's collection.

*Elacatidae*

**Eurystethus californicus** Mots.—Vide H. C. Fall.

*Pythidae*

**Lecontia discicollis** LeC.
**Pytho seidlitzi** Blair—November, 1927.
**Priognathus monilicornis** Rand.

*Pyrochroidae*

**Ischalia vancouverensis** Harr.—Rare; 1927.
**Dendroides bicolor** Newn.—Rare; on apple tree.
**Dendroides** sp.—"Probably **D. ephemeroides** Mann., but cannot verify it", wrote Mr. Frost.

*Pedilidae*

**Eurygenius campanulatus** LeC. — Det. by J. J. du Bois.

*Anthicidae*

**Anthicus simiolus** Csy.
**Anthicus floralis** Linn.

*Elateridae*

**Lacon profusus** Can.—Rare. [Now a synonym of **brevicornis** LeC.].
**Lacon rorulentus** LeC.—Scarce.
**Athous cribratus LeC.**
**Athous rufiventris ferruginosus** Esch.
**Athous pallidipennis** Mann.
**Ludius kendalli** Kby.
**Ludius fraternus** LeC.—Det. by Quirsfeld; frequent on flowers.
**Ludius** sp. near **fraternus** LeC.
**Ludius volitans** Esch.—Det. by Brown and Quirsfeld.
**Ludius umbricola** Esch.—Det. by Knull and Brown.
**Ludius caracinus** Germ.—Det. by Brown and Quirsfeld.
**Ludius kaweana** Fall—Det. by Fall (originally as **rufipennis** Fall), and Quirsfeld
**Ludius sagitticollis** Esch.—Det. by Fall.

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* Parts 1 and 2 appeared in this journal in 1947 and 1948: 44:24-27; 45:21-24. As before, I am particularly indebted to Mr. C. A. Frost for identifications, or for help in obtaining them from specialists. I wish also to acknowledge the generous help received from all persons listed below; without it the list could not have been made.

† Editor's Note:—As with the two previous papers of this series, Mr. Hugh B. Leech, from whom the typescript was received, is responsible for the extensive editorial work and taxonomic checking so essential to a manuscript of this kind.—K.M.K.

**Ludius resplendens** Esch.—Det. by Brown.
**Ludius cruciatus festivus** LeC. — Det. by Brown.
**Ludius suckleyi** LeC.
**Ludius aereipennis** Kby. — Det. by Brown. The commonest wireworm pest; flies in May.
**Ludius carbo** Lec. ?
**Ludius rotundicollis** Say—Brown says "a complex".
**Ludius pudicus** Br.—Det. by Brown.
**Ludius propola columbianus** Br. — Det. by Brown; considered to be the same as **nubilus** LeC. by Fall. Rare; taken in 1931
**Ludius triundulatus** Rand.—Scarce; on pine in July.
**Ludius bombycinus** Germ.—Det. by Brown.
**Eanus maculipennis** LeC.
**Hemicrepidius morio** LeC.
**Hypnoidus nocturnus** Esch.—May 1, 1921; det. Quirsfeld.
**Hypnoidus nocturnus** var. **lucidulus** Mann. —Det. by Knull.
**Hypnoidus tumescens** LeC. — June 2, 1920; det. by Knull.
**Hypnoidus abbreviatus** Say—Det. by Knull.
**Hypnoidus striatulus** LeC.—Under a stone, 1927; det. by Quirsfeld.
**Hypnoidus ornatus** LeC.—Det. by Quirsfeld.
**Hypnoidus quadripustulatus** Fab. — August, 1927, under a stone; det. by Quirsfeld.
**Dalopius tristis** Br. ?—A female, probably of this species; det. by Brown.
**Dalopius** sp—An unknown species.
**Sericus incongruus** LeC. — A synonym of **brunneus** Linn., teste W. J. Brown.
**Agriotes nevadensis** LeC.—Det. by Quirsfeld; but det. as **A. ferrugineipennis** by Van Dyke.
**Agriotes tardus** Br.—Frost's note says "instead of **nevadensis**", and that these species are being studied by Becker.
**Ampedus carbonicolor** Esch. — Taken on Thornhill Mountain. Det. by Quirsfeld, Van Dyke and Knull
**Ampedus** sp., nearest to **nigrinus** Herbst — Fall's note: "Never saw a **nigrinus** from N. America".
**Ampedus affinis** LeC.—Vide H. C. Fall.
**Ampedus behrensi** Horn—Det. by Knull and Quirsfeld.
**Ampedus varipilis** Van Dyke—From rotten spruce. Det. by Knull.
**Ampedus bimaculatus** Van Dyke—Taken in 1935; det. by Knull and Fall.
**Ampedus phelpsi** Horn—Det. by Knull, Van Dyke and Fall.
**Ampedus dimidiatus** LeC.
**Ampedus pullus** Germ.—Det. by Brown.
**Ampedus hoppingi** Van Dyke—On Salix. Det. by Knull, but called a variety of **phelpsi** by Fall.
**Ampedus moerens** LeC.—Det. so by Fall, but called "**moerens** LeC. ?" by Brown.
**Megapenthes caprella caprella** LeC.—Det. by Brown.
**Cardiophorus fenestratus** LeC. — Taken in 1932; det. by Knull.

*Melasidae*

**Epiphanis cornutus** Esch.
**Microrhagus pectinatus** LeC.

*Throscidae*

**Pactopus horni** LeC.—Det. by Fall.
**Throscus carinicollis** Schffr.—Det. by Fall.

*Buprestidae*

**Dicerca tenebrosa** Kby.—One taken in 1934.
**Buprestis maculiventris** var. **rusticorum** Kby. —in numbers on burnt spruce.
**Buprestis adducta** Csy. ?—"Possibly syn. of **rusticorum**" was Frost's note.
**Buprestis langi** Mann.—Scarce; specimens show much variation in colour.
**Melanophila acuminata** Deg.
**Melanophila fulvoguttata** var. **drummondi** Kby.—On flowers.
**Anthaxia aeneogaster** Lap.—Scarce; taken on yellow avens, wild roses and **Crataegus.**
**Anthaxia aeneogaster** var. **foveicollis** LeC.— On wild rose.
**Chrysobothris trinervia** Kby. — Taken in 1933; vide Fall.
**Agrilus anxius** Gory—Found in 1931; the first **Agrilus** taken in this district in 10 years of collecting. Mr. Frost thinks it is probably the poplar species recently described as
**Agrilus politus** Say.

*Tenerbrionidae*

**Phellopsis porcata** LeC.—Under bark; June.
**Eleates explanatus** Csy.—June, 1921.
**Scaphidema pictum** Horn—Taken in 1927.
**Platydema oregonense** LeC.—Taken in 1931.
**Tribolium ferrugineum** Fab.—In flour, giving it a bad smell and taste; also in various meals.
**Tribolium confusum** Duv.—In a dried insect; also feeds on black pepper.
**Iphthimus serratus** Mann.—Rare.
**Iphthimus opacus** LeC. ?—Common in rotten wood and about roots of trees.
**Upis ceramboides** Linn.—Scarce; on logs in June.
**Boros unicolor** Say—Scarce; on pine, April to September.

*Melandryidae*

**Tetratoma concolor** LeC.
**Orchesia castanea** Melsh. — Reared from fungus on birch, 1937. Det. by H. C. Fall, who said it was a new record for the West.
**Prothalpia holmbergi** Mann.
**Melandrya striata** Say.
**Phryganophilus collaris** LeC. — Taken on June 6, 1920; scarce, on flowers and leaves.
**Xylita laevigata** Hellw.
**Zilora hispida** LeC. — From under hemlock bark. Det. by Van Dyke and Mank.
**Scotochroa basalis** LeC.—Vide Miss Mank.
**Stenotrachelus arctatus** Say—Rare.

*Ptinidae*

**Trigonogenius globulum** Sol.—Found in pail of condition powder for cattle.
**Ptinus fur** Linn.—On books, December 31, 1924: vide Fall.

**Ptinus tectus** Boield.—Det. Fall. Another name is **ocellus** Br.

*Anobiidae*

**Utobium elegans** Horn — Rare, July; vide Fall.
**Coelostethus americanus** Fall.
**Stagetus profunda** LeC.—Very rare. Det. by Fall.

*Ciidae*

**Cis impressa** Csy.—In fungus on **Betula** sp.; scarce.
**Cis serricollis** Dury?
**Cis criddlei** Dury—Det. by Dury.
**Cis hystricula** Csy.—vide A. S. Nicolay and compared with the type.
**Cis** sp. near **hystricula** Csy.
**Xestocis moznetti** Dury—On a hard woody fungus, June and July, 1931. Vide Nicolay; but equals **ephippium** Mann., teste Fall.
**Xestocis biarmata** Mann.—Det. by Nicolay.
**Octotemnus denudatus** Csy. — From fungus on **Betula** sp.

*Scarabaeidae*

**Aegialia rufescens** Horn—Det. by Fall.
**Aegialia lacustris** LeC.—Under driftwood in river sand, August, 1927. Det. by Brown.
**Aphodius omissus** LeC.
**Aphodius fimetarius** Linn.—Common about stable-yard and pasture.
**Aphodius** sp. near **congregatus** Mann.—Det. by Cartwright. Common in the fall on fresh cow dung; also taken on Thornhill Mountain.
**Aphodius tenellus** Say—Det. by Brown.
**Aphodius pectoralis** LeC.—Det. by Fall.
**Aphodius vittatus** Say—Found on barn window, 1931, and under boxes of dung.
**Phyllophaga anxia** LeC—Common in fruit orchards at apple blossom time.
**Polyphylla ruficollis** Csy., var.—Scarce; the larvae were destructive to blackberry roots.
**Dichelonyx backi** Kby. — Taken by Fred Michaud on Thornhill Mountain, lying on snow banks. Subsequently found by me on thimbleberry bushes by the Skeena bridge, 1939.
**Dichelonyx fulgida** LeC.

*Cerambycidae*

**Tragosoma harrisi** LeC.—Rare; one dead under bark of **Tsuga** sp., September, 1920; afterwards took a few at lighted windows in July.
**Spondylus upiformis** Mann.—Flying in June, and on spruce logs.
**Asemum atrum** Esch.
**Tetropium velutinum** LeC.
**Tetropium columbianum** Csy.
**Criocephalus agrestis** Kby.
**Stromatium** sp.—Taken in 1938. Mr. Frost's note: "Probably undescribed."
**Stenocorus lineatus** Oliv. — Larvae under pine bark; adults feed on pine pollen in early spring.
**Pachyta lamed** Linn. — Found on **Aruncus sylvester** in July.
**Pachyta armata** LeC. — From Thornhill Mountain.
**Evodinus vancouverensis** Csy.—On flowers of **Aruncus sylvester** in July.
**Pidonia scripta** LeC.—Frequent on flowers of osier dogwood and thimbleberry in June.
**Grammoptera filicornis** Csy.—June, 1920.
**Acmaeops pratensis** Laich.—Scarce.
**Acmaeops proteus** Kby.—Rare.
**Leptura obliterata** Hald. — Frequent on "everlasting" flowers in August.
**Leptura vitiosa** LeC.—Typical form. Said by Hopping to be a synonym of **obliterata.**
**Leptura propinqua** Bland.
**Anoplodera chrysocoma** Kby.—Frequent on **Aruncus** and everlasting, July and August.
**Anoplodera aspera** LeC. — Typical form; scarce, on everlasting.
**Anoplodera aspera** var. **parkeri** Hippisley—Rare; taken in 1920; type in C. A. Frost's collection.
**Anoplodera nigrella** Say—Very rare; from Thornhill Mountain.
**Anoplodera nigrella** var. **praestans** Csy.—Rare.
**Anoplodera sanguinea** LeC.—Scarce, on everlasting; on poplar in July.
**Anoplodera canadensis cribripennis** LeC. — Typical, all red as in type; scarce, on logs in August.
**Anoplodera canadensis** var. **ebena** Leng — "Nearly typical"; scarce, on flowers of everlasting.
**Anoplodera sexmaculata** Linn. — Frequent, on **Aruncus.**
**Anoplodera tibialis** LeC.
**Anoplodera crassipes** LeC.—Rare; on everlasting.
**Anoplodera valida** LeC.
**Desmocerus piperi** Webb—Breeds in the pith of the western red-berried elder, **Sambucus.**
**Leptalia macilenta** Mann.
**Semanotus litigiosus** Csy.
**Semanotus ligneus** var. **basalis** Csy.
**Semanotus ligneus** var. **terracensis** Csy. — Described by Casey from specimens collected by me when I was Mrs. Hippisley.
**Semanotus ligneus** var. **amplus** Csy.—The larvae occur under the bark of cedar.
**Phymatodes** sp. near **decussatus** LeC.—Rare.
**Xylotrechus undulatus** Say—Frequent.
**Xylotrechus undulatus** var. **columbianus** Csy.?
**Xylotrechus annosus** Say—Frequent on cottonwood logs, and bred from galls on young poplar branches.
**Neoclytus muricatulus** Kby.
**Plectrura spinicauda** Mann. — First caught feeding on ripe wild raspberries; later reared from the stems of Devil's club (**Fatsia** sp.). My attention had been called to holes in the stems; finding a thicket apparently infested I cut stems and put them into a flat pan in a muslin bag, which was kept in a cool room. The beetles emerged in due course and when I examined the cage were running about actively. They appeared smaller than those picked from raspberries; Mr. Frost said they might me immature but I do not see how they could be.

The egg seems to be laid at the base of a leaf or branch bud or young growth in the just-burst stage. The young larva must first feed on this because the bud never does develop, but wilts and droops. Where one finds this the grub is always below in the main stem, as it seems to feed downwards in the pith.

**Monochamus scutellatus** Say, western variety.
**Monochamus maculosus** Hald.
**Acanthocinus obliquus** LeC.
**Saperda populnea** Linn.—Reared from round galls on young white poplar.
**Saperda populnea** var. **moesta** LeC. — On cottonwood logs.
**Saperda calcarata** Say.
**Oberea quadricallosa** LeC.

*Chrysomelidae*

**Donacia hirticollis** Kby.
**Donacia emarginata** Kby.—Mr. Frost said "Probably the var. **pacifica** Schffr."
**Orsodacne atra** Ahrens — On gooseberry leaves and flowers. Also the vars. **childreni** Kby. and **trivittata** Lac.
**Syneta carinata** Mann. — From Thornhill Mountain.
**Syneta hamata** Horn—Frequent on thimbleberry, **Rubus parviflorus,** in May and June.
**Syneta simplex** LeC.—On wild bitter cherry in May.
**Zeugophora atra** Fall—Scarce, July.
**Pachybrachys** sp.—Fall said: "near **lustrans** LeC. and **californica** Fall; does not fit either very well."
**Pachybrachys peccans** Suffr.—A dark form taken in fermenting grass, July 1936; vide H. C. Fall.
**Diachus catarius** Suffr.—Rare.
**Adoxus obscurus** Linn.—Scarce, but found all season.
**Adoxus villosulus** Schrank — Common all season.
**Phaedon oviformis** LeC. — Found in all stages of development on a small species of **Veronica,** locally known as false forget-me-not, that grows in muddy places or in field ditches. The plants, about six inches high, are covered with beetles and larvae in all stages during June and July; they completely destroy the plants, then suddenly disappear.
**Phaedon armoraciae** Linn.—Det. by Fall; also called **americanus** Schffr.
**Chrysomela interrupta** Fab. — On alder; sometimes common enough in June to be a pest. Vide Schaeffer.
**Chrysomela aeneicollis** Schffr.—Scarce.
**Phyllodecta americana** Schffr.—On willow in July; scarce.
**Galerucella punctipennis** Mann. — May 22, 1928. Scarce on willow, birch and poplar.
**Galerucella carbo** LeC.—Common on willow; sometimes a bad pest; June.
**Galerucella nymphaeæ** Linn.—On lily pads, Lakelse Lake. June 8, 1923.
**Altica bimarginata** Say — Frost's note: "Probably **plicipennis** Mann. or var. **ambiens** LeC."
**Altica tombacina** Mann.—Vide Gentner.
**Altica** sp., nearest **aenola** Blatch; vide Fall.
**Chalcoides helxines** Linn.—Common on willow, May and June.
**Crepidodera robusta** LeC.—Vide Fall.
**Hippuriphila equiseti** Hatch and Beller—Ex rotten leaves, March 19, 1937. Det. Gentner; probably the same as **mancula** LeC.
**Longitarsus erro** Horn—From rotten leaves, March 19, 1937; det. Gentner.
**Phyllotreta albionica** LeC.
**Phylotretta decipiens** var. **ordinata** Chitt. — Det. by Gentner.
**Psylliodes punctulata** Melsh.

*Platystomidae*

**Eurymycter fasciatus** Oliv.—Taken in 1933.

*Curculionidae*

**Rhinomacer elongatus** LeC.—On pine shoots, Jack Pine Flats. Vide H. C. Fall.
**Apion centrale** Fall—Seen by H. C. Fall.
**Dyslobus decoratus** LeC.—Taken in 1931; det. C. Dury.
**Panscopus** sp.—"May be **pallidus**" wrote Mr. Frost.
**Brachyrhinus ovatus** Linn.
**Sciopithes obscurus** Horn—Det. Fall.
**Geoderces incomptus** Horn?
**Sitona tibialis** Herbst.
**Trichalophus constrictus** LeC.
**Phytonomus nigrirostris** Fab. — Common under bits of board in the spring, 1928.
**Phytonomus trivittatus** Say.
**Lepyrus oregonus** Csy.—Taken in 1933; det. Fall.
**Listronotus** sp., near **squamiger** Say.
**Pissodes fasciatus** LeC.?
**Pissodes** sp., near **affinis** Rand., "but not that species" (Frost).
**Paraplinthus carinatus** Boh.
**Paraplinthus scrobiculatus** Mann.
**Hypomolyx piceus** Deg.—On pine.
**Dorytomus** sp.
**Notaris puncticollis** LeC.
**Trachodes quadrituberculatus** Mann. — Det. Fall.
**Aparapion horridus** Mann.—Det. Fall.
**Proctorus decipiens** LeC.
**Tychius picirostris** Fab.—Taken in March, 1937, on lichens and rotten hemlock.
**Magdalis aenescens** LeC. — About gardens and wild fruit.
**Magdalis hispoides** LeC.
**Anthonomus** sp.—"Near **simiolus** Blatchley."
**Orchestes parvicollis** LeC.
**Orchestes** sp., near **pallicornis** Say. Det. Fall.
**Auleutes cruralis** LeC., or near.—Taken in fermenting grass, August, 1936.
**Auleutes epilobii** Payk.—Mr. Frost says this is European, and suggests that it and the preceding species are the same. However, I often took the latter. and always in the tops of fireweed (**Epilobium**) when the plants were about half grown; the plants were always distorted.
**Ceutorhynchus decipiens** LeC.—May, 1933; det. Fall.
**Carphonotus testaceus** Csy. — Vide L. L. Buchanan.

**Cossonus subareatus** Boh.
**Cossonus quadricollis** Van Dyke.
**Cossonus** sp., underscribed?
**Rhyncolus brunneus** Mann.—In rotten wood; vide Buchanan.
**Rhyncolus spretus** Csy.—Vide Buchanan.
**Rhyncolus macrops** Buch.—Two paratypes.

*Scolytidae*

**Scolytus tsugae** Sw.
**Crypturgus borealis** Sw.—April, 1937; bred from spruce bark; vide Fall and Knull.
**Dolurgus pumilus** Mann.
**Polygraphus rufipennis** Kby.—April 6, 1921; on spruce.
**Dendroctonus murrayanae** Hopk. — From spruce; vide Blackman.
**Dendroctonus pseudotsugae** Hopk.
**Dendroctonus valens** LeC.
**Phloeosinus punctatus** LeC. — March, 1942, on dead cedar branches; det. Blackman.
**Alniphagus aspericollis** LeC. — May 5, 1920; frequent on western alder; vide Blackman.
**Hylurgops rugipennis** Mann.—Det. Knull.
**Hylurgops lecontei** Sw.
**Hylastes nigrinus** Mann.
**Trypodendron retusum** Lec.—Det. Knull.
**Trypodendron rufitarsis** Kby.—November 4, 1923, and March, 1933. Vide Knull and Blackman.
**Trypodendron cavifrons** Mann. — August, 1927, and March 21, 1937. Det. by Blackman.
**Gnathotrichus alni** Blackm.—Det. by Knull.
**Pityophthorus pseudotsugae** Sw. — Det. by Knull.
**Pityophthorus confertus** Sw. — From green pine twigs, in May. Teste Blackman.
**Pityophthorus** sp.—An unknown species.
**Ips tridens** Mann.—Det. by Blackman.
**Ips yohoensis** Sw.? — From spruce. Vide Blackman.
**Ips concinnus** Mann.
**Ips** sp.—A species unknown to Knull.
**Ips** sp.—A species unknown to Blackman.
**Orthotomicus vicinus** LeC.—Found on pine, February 11, 1938. Det. by R. Hopping.
**Dryocoetes septentrionis** Mann.—March 21, 1937. Det. by R. Hopping.
**Dryocoetes affaber** Mann.—Vide Knull.
**Dryocoetes betulae** Hopk.—Det. by Blackman.
**Dryocoetes pseudotsugae** Sw. — March 21, 1937; vide Swaine.

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# REVISED CONSTITUTION OF THE ENTOMOLOGICAL SOCIETY OF BRITISH COLUMBIA

## ADOPTED APRIL 28th, 1955

**Article 1**

**Title**

This Society shall be known as the Entomological Society of British Columbia, in affiliation with the Entomological Society of Canada.

**Article 2**

**Object**

The object of the Society shall be to foster the advancement, exchange and dissemination of entomological information.

**Article 3**

**Membership, Dues and Expenditures**

a) Any person interested in entomology may become a member on application to the Secretary of the Society and on payment of the annual dues.

b) A member may withdraw from the Society upon giving notice in writing to the Secretary.

c) An annual fee necessary for the operation of the Society shall be levied from each member as provided for in Section 1 of the By-Laws.

d) The executive shall have power to meet expenses required in the normal operation of the Society business. Such expenditures shall be subject to subsequent ratification at the Annual meeting by the majority of the members present.

e) A member who neglects to pay the annual fee for two consecutive years shall automatically cease to be a member.

**Article 4**

**Meetings**

a) The Annual meeting of the Society shall be called each year by the President at a time and place suitable to the majority of the members.

b) Other meetings of the Society may be held at any time or any place with the approval of the Executive and upon notification to the members.

c) Seven members in good standing shall constitute a quorum at the Annual meeting.

d) The meetings shall be informal insofar as possible.

**Article 5**

**Officers**

The officers of the Society shall consist of President, President-Elect, Vice-President, Secretary-Treasurer, Editor, Immediate Past President and three Directors These officers shall constitute the Executive with full power to act on behalf of the Society within the bounds of the constitution and to appoint committees as necessary.

**Article 6**

**Elections**

Elections shall be held once a year at the Annual meeting, and officers so elected shall remain in office until the next Annual meeting. The office of President shall not be held by the same member for more than two consecutive years. Normally, the President-Elect shall take office as President one year after his election as President-Elect.

**Article 7**

**Duties of Officers**

a) The President or designated alternate shall preside at all meetings and act ex-officio on all committees. He shall have primary responsibility for the program and arrangements of the Annual meeting.

b) The Secretary-Treasurer shall maintain a record of all meetings and act as the custodian of all minute books and correspondence. He shall also receive and disburse all funds, prepare the annual financial statement, and file a copy of the same with the Registrar of Companies as required under the "Societies Act".

c) The Editor shall act as editor of the "Proceedings" and other publications of the Society.

**Article 8**

**Alteration of the Constitution**

The Constitution may be altered or amended at any Annual meeting of the Society with the approving vote of three-quarters of the members present and in good standing. Such alterations must be made by notice of motion, which shall have been sent to the Secretary and a copy of such forwarded to all members at least two weeks before the Annual Meeting.

**Proposed By-Laws**

1. a) The annual fee for full membership shall be $2.00.
   b) A student membership fee shall be set at one-half the full membership fee, such a member having the privileges of a full membership.
   c) Honorary life members may be conferred at any Annual meeting of the Society by approval of a majority of the members present and in good standing. Honorary life members shall have all privileges of full members, without payment of dues.
   d) The fiscal year of the Society shall coincide with the calendar year, fees are payable in advance, at the time of the Annual meeting.
2. The President of the Society shall be the representative on the Board of Directors of the Entomological Society of Canada. The President is at liberty to appoint a substitute to represent him at the Annual Meeting of the National Society in the event that he is not able to attend.
3. a) The annual financial statement shall be presented by the Secretary-Treasurer at the Annual meeting.
   b) An auditor shall be appointed at each Annual meeting to audit the accounts of the Society.
4. The By-Laws may be changed at any Annual meeting by a motion approved by the majority of the members present and in good standing.

## SCIENCE NOTES

### *Coleophora pruniella* Clemens, a Casebearer New to the Okanagan Valley (Lepidoptera: Coleophoridae)

When Mr. Alex Watt, Horticultural Branch, British Columbia Department of Agriculture, West Summerland, was visiting an orchardist at Trout Creek Point, Summerland, in 1954, he noticed a number of cherry leaves showing an unusual type of injury, presumably caused by an insect. On visiting the orchard, I found that the cause of the trouble was a casebearer, subsequently identified by Dr. T. N. Freeman, Entomology Division, Ottawa, as the cherry casebearer, *Coleophora pruniella* Clem. This is the first known record of this species for the Okanagan Valley of British Columbia. The first and only other recorded occurrence of *C. pruniella* for the Province was at Creston in 1947 (Waddell, 1952).*

Several hundred mature casebearer larvae were collected on June 18 and kept in an insectary. Moths and parasites began emerging two weeks later; parasitism was approximately 0.75 per cent. Dr. W. R. M. Mason, Entomology Division, Ottawa, identified the parasites as *Bracon gelechiae* Ashm. and *Agathis* sp. near *conspicuus* (Wesm.). These species were not reported by Waddell (1952) among 23 species of Hymenoptera listed as parasitic on larvae and pupae of the cherry casebearer.

—*M. D. Proverbs, Associate Entomologist, Entomology Laboratory, Summerland, B.C. Contribution No. 3332, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.*

* Waddell, D. B. Biology and control of the cherry casebearer, *Coleophora pruniella* Clemens, in British Columbia. Proc. Ent. Soc. British Columbia 48:85-89. 1952.

## Another Record of Urinary Myiasis by Fannia Canicularis (L)

(Diptera: *Anthomyia,* in part).—On August 6 1953, a first year medical student of the University of British Columbia, working protem. as an orderly in New Westminster Hospital, sent in a letter of enquiry, with two maggots. In part, he said " . . . these insects were found in large numbers in a urine specimen of a five year old girl. They were found in repeated voidings but in diminishing numbers. The doctor brought in another (urine) specimen several days later but none could be found in it nor in a stool specimen . . . The doctor described the child as being very wild and uncooperative but she quieted down after treatment with terramycin".

The maggots were those of the anthomyid fly *Fannia* (*Homalomyia*) *canicularis* (L), the lesser housefly, whose larvae usually develop in human faeces and decaying vegetation, where the eggs hatch in about twenty-four hours and the larval growth is completed in six to twelve days and the pupal period occupies about nine days.

There are numerous records of the larvae of this species causing gastric and intestinal myiasis of man. The infestation generally occurs by somebody swallowing the eggs of the fly which are laid on a variety of household foods exposed to the air, and it is one of the few insects that can develop in the digestive tract. The presence of the maggots is usually indicated by nausea, vertigo and violent pains; the larvae in many cases are expelled by vomiting. If they occur in the intestine they are expelled with the faeces and their presence is indicated by diarrhoeal symptoms, abdominal pains or haemorrhage caused by the traumatic lesions of the mucous membrance of the intestine which the larvae affect (partly, after Matheson).

In addition, this species has been recorded from the human urethra of both males and females. Detwiler* (1929) reported a case of urinary myiasis caused by the larvae of this insect. The infestation in the urinary tract probably occurs by flies depositing their eggs about the anus or the external genital orifice and the tiny larvae hatching from the eggs, work their way up into the vagina and sometimes into the urethra, whence they normally are expelled after they have completed their development. Since these flies are common in warm weather the deposition of eggs may take place when a person is lying asleep on top of a bed in a naked or partly clothed condition. Usually no treatment is necessary because the larvae are expelled anyway.

It is surprising that such an infestation should occur in so young a child but if the home was unclean and the girl had not been frequently bathed, the infestation may have occurred when she was lying exposed on top of a bed.— *G. J. Spencer, University of British Columbia.*

* Detwiler, J. D. Notes on myiasis of the urinary passage caused by larvae of Fannia. 59th Ann. Rept. Ent. Soc. Ontario, 1928.57-59. 1929.

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## Collecting *Tabanus* Males

I have collected Tabanids for quite a number of years, but have never had the luck to find many males. This year, however, I found out that our early species *T. procyon* O.S. seems to congregate on rocks (large outcroppings of bedrock) as soon as they emerge. I took 41 males and 39 females on outcroppings of bedrock (about ½ an acre in extent) in 6 days. I was surprised that the emergence lasted that long.

It wasn't very warm—62° high the first day; several days were warmer afterwards. First of all I thought they went on the rocks to copulate (probably the real reason), but I caught only one pair in copulation. It might be that the rocks were a little warmer. There are two small springs in the near vicinity, one on each side of the rocks. I am wondering if some of our other B.C. Tabanids have the same habit.

There were cows quite near but apparently the flies didn't bother them. None of the females flew round or settled on me, so possibly they don't try for blood until after they are fertilized. Perhaps someone else can answer that.—*H. R. Foxlee, Robson, B.C.*

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## Tropical Rat Mites in a Domestic Sparrow's Nest

The latter part of July 1955 I received a telephone call from the local R.C.A.F. depot at Sea Island regarding a plague of mites in a hangar, and requested that specimens be sent in for identification. The messenger left some specimens in a bottle somewhere outside our building where they were found six weeks later and handed to me. I cleared and mounted them and found that the mites were *Bdellonyssus bacoti* (Hirst), the tropical rat mite which the Station Medical Officer told me were found to have originated in a sparrow's nest.

A bird's nest is an unusual place for rat mites so it is likely that an infested nest was abandoned by the rats and the fabric used by the sparrows: upon the removal of the nest, the mites soon disappeared.
—*G. J. Spencer*, University of British Columbia.*

* Spencer, G. J. The menace of rat parasites in Vancouver in 1936. Proc. B.C. Ent. Soc. 33: 44, 45. 1937.

## Control of the Cabbage Maggot, *Hylemya Brassicae* (Bouché), in Rutabagas - 1954*

In evaluating the treatments the categories of injury were as follows:

Clean—no maggot marks visible
Light—superficial maggot injury
Moderate—marketable for second grade after trimming
Severe—unmarketable

**Exp. No. 54-17.** Furrow, Band and Spray Methods. Five replicates in randomized blocks. Planting date, July 15. Band treatments applied July 12. Furrow treatment applied July 15. Second spray treatment applied August 31. The rutabagas were harvested October 29, appraisal being based on 40 roots per plot, 200 per treatment.

| Insecticide | Method of Application | Amount Actual/acre (pounds) | Total Infestation Index | Total Damage Index | Damage Reduction (per cent) |
|---|---|---|---|---|---|
| Check | | | 794 | 794 | — |
| Heptachlor dust 2.5 | Band | 5.08 | 125 | 16 | 97.8 |
| Heptachlor dust 2.5 | Furrow | 2.54 | 141 | 38 | 95.2 |
| Aldrin dust 2.5 | Band | 5.08 | 154 | 38 | 95.2 |
| Aldrin dust 2.5 | Furrow | 2.54 | 134 | 46 | 94.2 |
| Aldrin emulsion | Surface | 4.15 | 168 | 46 | 94.2 |
| Heptachlor emulsion | Surface | 2.18 | 149 | 50 | 93.7 |
| Isodrin dust 2.0 | Furrow | 2.54 | 337 | 234 | 70.5 |

An infestation index was determined by placing penalties on infested plants as follows: Clean—0; light—1; moderate—2; severe—4; for the damage index only the two latter categories were used. Maximum damage index total 800.

* The methods of application and evaluation are those described in detail and discussed by King, K. M. and A. R. Forbes, Jour. Econ. Ent. 47(4): 607-615, 1954. The work supplements that of King, K. M., A. R. Forbes, D. G. Finlayson, H. G. Fulton, and A. J. Howitt, Jour. Econ. Ent. 48(4):470-473, 1955; and Forbes, A. R. and K. M King, Jour. Econ. Ent. (in press).

The results confirm earlier findings of co-operative work carried out in British Columbia and Western Washington that effective control of root maggots attacking rutabagas is possible with heptachlor and aldrin under a wide range of conditions provided these chemicals are present in adequate amounts throughout the time protection from infestation is needed.

*Angus J. Howitt,*
*Assistant Entomologist,*
*Western Washington Experiment Station,*
*Puyallup, Wash.*

## IN MEMORIAM

### James Rushton John Llewellyn-Jones, 1894-1954

James R. J. Llewellyn-Jones, an only child, was born in Newcote West Avenue, Exeter, England, on 27th July, 1894. His father died in 1902 and during the First World War when James was in one of the branches of the armed services, his mother (nee Rushton) passed away; early in 1951 his aunt, sister of his mother, also died leaving James the last remaining member of both sides of his family.

I have not been able to get any information about his life in England beyond the fact that he was M.A. in Theology from Cambridge University, probably completing his work there after the war and was later attached to Exeter Cathedral for a short time. He was elected a Member of the Royal Entomological Society of London in 1925.

He came out to Canada in 1930 and in 1931 settled at Arranmore, Cobble Hill, in a large house and some twelve acres of beautiful grounds. Beyond telling us that he was the owner of the smallest registered yacht in the British Empire he very rarely said anything about himself and seemed to spend his time collecting and rearing Macro-Lepidoptera. Shortly after coming out, he joined the Entomological Society of British Columbia of which he was an enthusiastic member, never missing an annual meeting and, over the years, publishing nine papers in our Proceedings, on the "Food plants of British Columbia Lepidoptera". He was President of our Society from 1943 to 1947 inclusive and showed more presidential enthusiasm than any other occupant of the position in thirty years.

In his Presidential addresses he advocated and strove to accomplish three objects (1) the increase of entomological literature in the Province, (2) the establishment of scholarships in aid of deserving students in Entomology and (3) a reserve fund for publishing our Proceedings. Towards the first two items, he generously willed his entomological library to the University and for some seven years awarded the entomological scholarship which bore his name, to the University. To establish a reserve fund for publishing our Proceedings, he, as a single man without any relatives and being possessed of considerable private means, willed his estate upon his death, to the Society. Being a very modest and quiet man, he was insistent that this matter should not be made known to the members of the Society but now that he has passed on, it can be mentioned as an indication of his general interest in Entomology and his wish to help our Proceedings. Unfortunately, the second world war so depleted his investments which were still in England, that in 1951 he was forced to cancel this disposition of his estate. At this period also, he was forced to put up his house and grounds for sale and early in 1954, he moved to a hotel in Vancouver, sending his large cabinet of some five thousand specimens of Macro-Lepidoptera to the University for sanctuary. Since he had published "An Annotated Check List of the Macro-Lepidoptera of British Columbia" as Occasional Paper No. 1 of the Entomological Society of British Columbia in June 1951, at his own expense, his collection of perfectly mounted, labelled and catalogued specimens makes, with this annotated check list, a major controbution to our science and to the University of this Province.

After moving to Vancouver Mr. Jones used to come out to the University every Wednesday morning for a couple of hours to work over his collection, insert new material and generally keep it up to date; this, in spite of the fact that for a couple of years he had been in extremely poor health. By the autumn of 1954 his health had improved very considerably and the doctors' reports were very encouraging. On the 24th of November he came out to the University as usual, was very cheerful, looked quite fit and said that he was feeling very much better. Some time during the night of 25/26 November, he passed away in his sleep and was buried on December 4th from St. James Anglican Church. Six members of the Society acted as pallbearers and a considerable number of friends attended the service and followed to Ocean View Cemetery where our friend and colleague lies buried.

(My thanks are extended to Mrs. Janet Patterson, of Steveston, to Mr. A. D. Crease, solicitor of Victoria and to Mr. R. J. P. Barriscale of Vancouver for information concerning the early life of Mr. Llewellyn-Jones.)

—*G. J. Spencer.*

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of the

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# FURTHER RECORDS OF MALLOPHAGA FROM BRITISH COLUMBIA BIRDS

G. J. Spencer

Department of Zoology, University of British Columbia

In the Proceedings of the Entomological Society of British Columbia **44**, Feb. 16, 1948, I published "Some Records of Mallophaga" off birds of this Province, from a list I had been holding since 1933 at the request of Prof. A. W. Baker of the Ontario Agricultural College, pending the production of his contemplated monograph of the lice of Canadian Birds. Since then I have accumulated some 700 collections of Mallophaga which Miss Theresa Clay of the British Museum has graciously consented to name in small lots.

The 1948 list followed the arrangement of birds as given in "Birds of Western Canada," 1926, by P. A. Taverner (1) who used The American Ornithologists Union "Check List of North American Birds," 3rd Edition, 1910, with the supplements of 1912, 1920 and 1923, as published in the "Auk."

Meanwhile, Munro and Cowan published in 1947, "A Review of the Bird Fauna of British Columbia" (2) which adopted the arrangement of the 1931 edition of the American Ornithologists Check List and the 19th and 20th Supplements to it but without any revised A.O.U. Check List numbers; also, in many cases the systematic relationship of the birds, some synonomy, and names of authors, had been changed.

This present list of Mallophaga, therefore, follows Taverner's 1931 A.O.U. numbers and Ordinal and Family arrangements but uses Munro and Cowan's revised scientific names of species and authorities.

The nomenclature of the Mallophaga is from "A Check List of the Genera and Species of Mallophaga" by Hopkins and Clay (3), truly a prodigious and painstaking piece of work. Harrison (4) in 1916 considered 9 families and 56 genera: thirty-six years later, Hopkins and Clay list 10 families and 200 genera, no less than 98 genera being in the one family Philopteridae.

A few records below are from birds taken in Manitoba and a couple, like the peacock and an exotic pheasant, are from birds in Stanley Park Zoological Gardens, Vancouver. The birds from Manitoba occur in this province but I do not happen to have collections from local specimens.

An asterisk to the left of a bird's name indicates that the louse from it is a new host record.

Unless otherwise indicated, all of the lice were determined by Miss Theresa Clay; those determined by Dr. K. C. Emerson of Oklahoma, Prof. A. W. Baker of Ontario and Dr. R. A. Ward of Gonzaga University, Spokane, Washington, are indicated by initials to the right of each specific name. My cordial thanks are extended to these specialists, especially to Miss Clay who bore the brunt of the burden. I am very grateful also to the collectors below, for their contributions.

## KEY TO COLLECTORS

C.H.B.—Dr. C. H. Bastin, Vancouver
E.R.B.—E. R. Buckell, Salmon Arm.
D.C.—The late Donald Cameron, Kamloops
R.A.C.—The late R. A. Cumming, Vancouver
I. McT. C.—Professor Ian McT. Cowan, Vancouver
J.F.S.-F.—J. F. Stanwell-Fletcher
C.J.G.—Charles J. Guiguet, Victoria
L.J.—Leo Jobin, William Lake
H.M.L.—Hamilton Laing, Comox
G.J.M.—G. J. Mitchell, student
P.W.M.—Patrick Martin, Kamloops
W.S.M.—The late W. S. Maguire, New Westminster
K.R.—Kenneth Racey, Vancouver
J.W.—The late J. Wynne, Enderby
M.Y.W.—Prof. M. Y. Williams, Vancouver
R.W.—R. Webb, student

## MALLOPHAGA AND HOSTS

**Actornithophilus lari** (Packard, 1870)
**Larus glaucescens* Naumann, Glaucous-winged gull. Eighteen records, Langara Is., Bella Bella, Comox, Vancouver area. C.H.B., C.J.C., K.R., G. J. S. January to May, 1932 to 1947.

**Actornithophilus ochraceus** (Nitzsch), 1818
**Charadrius vociferus* (Linn.) Killdeer Plover. Iona Is. 19 March 1933. C.H.B.

**Actornithophilus totani** (Schrank), 1803
**Totanus melanoleucus* (Gmelin), Greater Yellow-legs. Lulu Is., Vancouver, 19 April 1932. K.R.; Goose Is., 23 July 1948. P.W.N.
**Totanus flavipes* (Gmelin), Lesser Yellow-legs. Enderby, 25 July 1949, J.W.; Kamloops, 25 Aug. 1935, M.Y.W.; Spider Is., 28 July 1948, P.W.M.

**Actornithophilus umbrinus** (Burmeister), 1838
**Steganopus tricolor* Vieillot, Wilson Phalarope. Armstrong, 28 May 1950. J.W.; Stum lake, Cariboo. 1 Aug. 1950. G.J.M.
**Erolia melanotus* (Vieillot), Pectoral Sandpiper. Five records, Iona Is., March, April, 1933, C.H.B. and Lulu Is., Vancouver, 30 Aug. 1941. K.R.
*Erolia minutilla* (Vieillot), Least Sandpiper. Grindrod, 7 Aug. 1951. J.W.; Kamloops, 31 Aug. 1934. G.J.S.

**Actornithophilus** Ferris, 1916. Sp. indet.
*Capella gallinago* (Linn.), Wilson Snipe. Five records, Nov. to Jan. 1953, 1954, Vancouver area. G.J.S.

**Amyrsidea phaeastoma** (Nitzsch), 1866. Det.: K. C. Emerson
*Pavo cristatus* (Linn.) Peacock. Stanley Park, Vancouver, 15 Oct. 1949. G.J.S.

**Anatoecus cygni** Subsp. (Denny) 1842, Det: K. C. Emerson.
**Cygnus buccinator* Richardson, Trumpeter Swan. Qualicum Beach, 15 Feb. 1946. G.J..S

**Austromenopon transversum** (Denny), 1842.
**Larus glaucescens* Naumann, Glaucus-winged Gull. Bella Bella, 19 March 1933. C.H.B.

**Austromenopon** Bedford, 1939. Sp. Being described by Timmermann.
*Ereunetes mauri* Cabanis, Western Sandpiper. Goose Is., 10 July 1948. C.J.G.
*Larus californicus* Lawrence California gull, Chilcotin. 19 Oct. 1951, L.J. *Uria aalge* Pontoppidan (*U. Troille*), Common Murre, Vancouver, 6 Feb. 1950. G.J.S.

**Carduiceps meinertzhageni** Timmerman. Recent.
*Erolia alphina* (Linn.), Dunlin, Red-backed Sandpiper. Lulu Is., Vancouver, 18 Nov. 1953. R. Webb. G.J.S.

**Carduiceps zonarius** (Nitzsch), 1866.
**Calidris canutus* (Linn.), Knot. Churchill, Manitoba, 17 June 1947. M.Y.W.
*Erolia melanotos* (Vieillot), Pectoral Sandpiper. Lulu Is., Vancouver, 30 Aug. 1941. K.R. Five records. Iona Is. C.H.B.
*Erolia minutilla* (Vieillot), Least Sandpiper. Grindrod, 7 Aug. 1951. J.W.; Kamloops, 3 Aug. 1934. C.J.S.
**Ereunetes mauri* Cabanis, Western Sandpiper. Sea Is., Vancouver, 7 May 1949, K.R.; Vancouver, 4 May 1953. G.J.S., A.W.B.

**Coloceras piageti** (Johnston and Harrison), 1912.
**Columba fasciata* Say, Band-tailed Pigeon. Tofino, 26 Aug. 1926. G.J.S.

**Colpocephalum flavescens** (Haan), 1829.
**Aquila chrysaetos* (Linn.), Golden-eagle. Blue River, 3 Sept. 1938, S. Keyes; Trinity Valley, 2 Oct. 1946. J.G.; Jasper, Alta., 23 Dec. 1944. I.McT.C.
*Haliaeetus leucocephalus* Linn., Bald Eagle. Kamloops, 9 Dec. 1933. G.J.S.; Merritt, 21 Aug. 1934. D.C.; Vancouver, March 1937. C.J.G.; Vancouver, 13 April 1938. G.J.S.; Nanoose, Jan. 1941. H.L.; Graham Is. 6 Aug. 1947. C.J.G.; Courtenay, 21 Feb. 1956. G.J.S.

**Colpocephalum impressum** Rudow, 1866.
**Accipiter cooperi* (Bonaparte), Cooper's Hawk. Lulu Is., Vancouver, 22 April 1932. R.A.C.; Kastberg Cr., 7 Aug. 1938. J.F.S.-F.; Vancouver, 23 Nov. 1953. G.J.S.
**Accipiter gentilis* (Linn.), Goshawk. Nine records, Vernon, Kamloops, Enderbv, Keithley Cr., 70-Mile, Comox, 1953 to 1947. E.R.B., J.G., H.M.L., C.H.S., G.J.S., J.W., M.Y.W.

**Colpocephalum kelloggi** Osborne, 1902. Sp. indet.
*Cathartes aura* (Linn.), Turkey Vulture. Cowichan Lake, 16 May 1940. I.McT.C.; Abbotsford, 2 Oct. 1943. W.S.M.; Courtenay, 25 Mav 1952. K.R.

**Columbicola baculoides** (Paine), 1912. K.C.E.
*Zenadura macrura* (Linn.), Mourning Dove. Kamloops, 6 Aug. 1934. G.J.S.

**Columbicola columbae** (Linn), 1758.
*Columba fasciata* Say, Band-tailed Pigeon. Ten records, Vancouver area, Comox, Tofino, 1926 to 1943.
*Columba livia domestica* Domestic Pigeon and vars. Vancouver area.

**Craspedorrhynchus dilatatus** (Rudow), 1869.
*Buteo lagopus* (Pontoppidan), Rough-legged Hawk. Alta Lake, 11 Nov. 1944. K.R.; Fraser Valley, 21 Oct. 1952. G.J.S.

**Craspedorrhynchus haematopus** (Scopoli), 1763.
*Accipiter gentilis* (Linn.), Goshawk. Vernon, I Nov. 1947. J.G.

**Craspedorrhynchus halieti** (Osborn), 1896.
*Haliaeetus leucocephalus* (Linn.). Bald Eagle. Graham Island, 6 Aug. 1947. C.J.G.

**Craspedorrhynchus nisi** (Denny), 1842.
**Accipiter cooperi* (Bonaparte), Cooper's Hawk. Vancouver, 23 Nov. 1953. G.J.S.

**Craspedorrhynchus platystomus** (Burmeister), 1838.
**Buteo swainsoni* (Bonaparte), Swainson's Hawk. Hilliers, Qualicum Beach, 28 May 1950. J.W.

**Cuclotogaster heterographus** (Nitzsch) 1866.
**Phasianus subsp.*, Reeves Pheasant. Stanley Park, Vancouver, 18 Feb. 1951. G.J.S.

**Cuculiphilus alternatus** (Osborn), 1902.
*Cathartes aura* (Linn.), Turkey Vulture. Abbotsford, 2 Oct. 1943. W.S.M.

**Cummingsiella ambigua** (Burm.) 1838.
*Capella gallinago* (Linn.), Wilson Snipe. Five collections, Vancouver, Nov. 1953 to Jan. 1954. G.J.S.

**Cummingseilla longirostricola** (Wilson), 1937.
*Numenius americanus* (Bechstein) Long-billed Curlew. Dog Creek, 15 June 1934. K.R.; White Lake, Okanagan Falls, 1 June 1941. I.McT.C.; Armstrong, 13 June 1948. J.W.; Hulcan, N. Okanagan, 5 June 1949. J.W.

**Dennyus spiniger** Ewing, 1930. Det. K. C. Emerson.
*Nephoecetes niger* (Gmelin), Northern Black Swift. Vancouver, 7 Aug. 1935. R.A.C. This is the first Canadian record and the second world record: known hitherto from the single female type specimen from Seattle, Wash., now in the U.S. National Museum.
Vancouver, 6 Sept. 1931. R.A.C. This single specimen was named by A. W. Baker and published in my 1948 list as *Dennyus truncatus* Olfers.
Vancouver, 28 June and 30 June 1955. Adults, eggs, nymphs. G.J.S. Vancouver, 7 June 1956. One adult, one nymph from 10 birds. G.J.S.

**Eureum spenceri** Emerson and Pratt, 1955. Det. K.C.E.
*Nephoecetes niger* (Gmelin), Black Swift. Types: Holotype male, New Denver, May/June 1941. James Hatter. Allotype female, Vancouver, Nov. 1931. G.J.S. Paratype , New Denver, May/June, 1941. J. Hatter.
Vancouver, 19 May 1955. Three adults, many eggs about to hatch and a few hatched, from 14 birds. G.J.S. Grindrod, 6 June 1954, two adults, J. Wynne.

**Falcolipeurus marginalis** (Osborn), 1902.
*Cathartes aura* (Linn.), Turkey Vulture. Abbotsford, 2 Oct. 1943. W.S.M.

**Goniodes colchici** Denny, 1842. Det. K.C.E.
*Phasianus* subsp. Pheasants. Kamloops, 6 Aug. 1934. D.C.; Vernon, 18 Oct. 1943. G.J.S.

**Goniodes lagopi** (Linn.), 1758. Det. K.C.E.
*Lagopus mutus rupestris* Gmelin, Rock Ptarmigan. Fort Churchill, Man., 18 Dec. 1952. C. E. Law.

**Goniodes pavonis** (Linn.), 1758. Det. G.J.S. and K.C.E.
*Pavo cristatus* Linn., Peacock. Stanley Park, Vancouver, 15 Oct. 1949. G.J.S.

**Goniodes stefani** Clay and Hopkins (=*Mammilatus* Rudow)
*Lophortyx californica* (Shaw and Nodder), California quail. South Vancouver, 23 April 1933. C. H. Brooks; Vancouver, 4 Feb. 1936, and 23 Jan. 1951. G.J.S.

**Hohorstiella frontalis** Carricker, 1949. Det. R. A. Ward.
*Columba fasciata* Say, Band-tailed Pigeon. Lulu Is. Vancouver, no date, 1929. R.A.C.

**Kurodaia cryptostigmatia** (Nitzsch), 1861.
**Otus asio kennicotti* (Elliott), Screech Owl. Vancouver, 21 March, 14 April 1932. R.A.C.

**Kurodaia haliaeti** (Denny), 1842.
*Pandion haliaetus* (Linn.), Osprey. Kamloops, 9 Aug. 1935. S. Keyes; Vancouver, 25 March, 1940. G.J.S.

**Kurodaia** Uchida, 1926, sp.
*Buteo swainsoni* (Bonaparte) Swainson's Hawk. Hilliers, 28 May 1950. J.W.

**Kurodaia** sp.
*Cryptoglaux funerea richardsoni* (Bonaparte). Little Boreal Owl. Blue River, 25 Jan. 1955. O. French.

**Kurodaia** sp.
*Cryptoglaux acadica* (Gmelin), Saw-Whet Owl. Grindrod, 3 March 1951. J.W.

**Kurodaia** sp.
*Bubo virginianus* (Gmelin), Great Horned Owl. Vancouver, 13 Feb. 1948. G.J.S.

**Laemobothrion canalense** Eichler, 1942.
**Cathartes aura* (Linn.), Turkey vulture. Courtenay, 25 May 1952. K.R.

**Laemobothrion maximum** (Scopoli), 1763.
**Buteo swainsoni* Bonaparte, Swainson's Hawk. Armstrong, 28 May 1950. J. Wynne; Lumby, 13 May 1948. J. Grant; Red Deer, Alta, 4 May 1938. I. McT. Cowan.

**Laemobothrion tinnunculi** (Linn.), 1758.
**Falco sparverius* (Linn.), Sparrow Hawk. Comox, 11 May 1939. H.M.L.
**Falco columbarius* (Linn.), Pigeon Hawk. Williams Lake, 10 May 1948. I.McT.C.

**Laemobothrion** Nitzsch, 1818. Sp.
*Haliaeetus leucocephalus* (Linn.), Bald Eagle. Graham Is., 6 Aug. 1947. C.J.G.

**Lagopoecus affinis** (Children), 1836. Det. K.C.E.
probably *Lagopus lagopus* (Linn.), Willow Ptarmigan. Fort Churchill, Man., Spring, 1953. C. E. Law No. 134.

**Lagopoecus colchicus** Emerson, 1949. Det. K.C.E.
*Phasianus colchicus* Gmelin, Ring-necked Pheasant. Vancouver, 3 Feb. 1955. G.J.S.
*Phasianus* subsp. Formosan White Pheasant. Pheasant Hatchery, Vancouver, 26 Feb. 1951. G.J.S.

**Lagopoecus gambeli** Emerson, 1949.
*Lophortyx californica* (Shaw and Nodder), California Quail. Three records, Vancouver, 1933. C.H.B.; 1936, 1951. G.J.S.

**Lipeurus caponis** (Linn.), 1758. Det. K.C.E.
*Gallus domesticus*. Hen. Vancouver, Feb. 1944. G.J.S.

**Lipeurus maculosus** Clay, 1938. Det. K.C.E.
*Phasianus colchicus* Gmelin, Ring-necked Pheasant. Lytton, 1 Sept. 1931. G.J.S.; Cloverdale, 5 Nov. 1932. G.J.S.; Cloverdale, 26 Nov. 1932. G.J.S.; Vernon, 18 Oct. 1943. G.J.S.; Vancouver, 3 Feb. 1955. G.J.S.

**Lunaceps actophilus** (Kellogg and Chapman), 1899.
**Erolia alpina* (Linn.). Dunlin, Red-backed Sandpiper. Lulu Is., Vancouver, 18 Nov. 1953. R. Webb; Vernon, Jan. 1935. E.R.B.

**Lunaceps drosti** Timmermann. Recent species.
*Calidris canutus* (Linn.), Knot or Red-breasted Plover. Churchill, Man., 17 June 1947. M.Y.W.

**Lunaceps numenii** (Denny), 1842.
**Numenius americanus* (Bechstein), Long-billed Curlew. Armstrong, 13 June 1948. J.W.

**Lunaceps phaeopi** (Denny), 1842.
**Phaeopus hudsonicus* (Latham), Hudsonian Curlew. Lulu Is., Vancouver, 30 April 1941. I.McT.C.

**Menacanthus stramineus** (Nitzsch), 1818. Det. K.C.E.
*Gallus domesticus,* Common hen. Vancouver, 15 March 1929; Feb. 1944. G.J.S.

**Menopon gallinae** (Linn.), 1758. Det. K.C.E.
*Gallus domesticus,* Common hen. Vancouver, Feb. 1944. G.J.S.

**Nosopon lucidum** (Rudow), 1869.
**Falco sparverius* (Linn.), Sparrow Hawk. Vancouver, 22 April 1936. G.J.S.
**Accipiter striatus velox* (Wilson), Sharp-shinned Hawk. Vancouver, 16 Dec. 1953. G.J.S.

**Ornithobius** Denny, 1842. Sp. Det. K.C.E.
*Cygnus buccinator* Richardson, Trumpeter Swan. Vancouver, Feb. 1949. G.J.S.

**Perineus ? grandis** (Piaget), 1880.
**Stercorarius pomarinus* (Temminck), Pomerine Jaeger. Goose Is. Banks, Q.C. Is., 27 July 1948. P.W.M.

**Piagetiella peralis** (Leidy), 1878. K.C.E.
*Pelecanus erythrorhynchos* Gmelin, White Pelican. Pelican Lake, Cariboo, August 1946. G.J.S.

**Quadraceps carrikeri** Hopkins and Timmerman. Recent.
*Catoptrophorus semipalmatus* (Gmelin), Willet. Lake Kerchoff, Cypress Hills, Sask., 10 Aug. 1926. M.Y.W.

**Quadraceps connexus** (Kellogg and Mann), 1912.
*Lobipes lobatus* (Linn.), Northern Phalarope. Kamloops, 21 Aug. 1934. G.J.S.; Goose Is., May 1948. P.W.M.

**Quadraceps falcigerus** (Peters), 1931.
*Totanus flavipes* (Gmelin), Lesser Yellow-legs. Kamloops, 25 Aug. 1935. M.Y.W.; Spider Is., 28 July 1948. P.W.M.; Enderby, 25 July 1949. J.W.

**Quadraceps fimbriatus** (Giebel), 1866.
*Steganopus tricolor* Vieillot, Wilson Phalarope. Stum Lake, Cariboo, 1 Aug. 1950. G. J. Mitchell; Armstrong, 28 May 1950. J.W.

**Quadraceps hiaticulae boephilus** (Kellogg), 1896.
**Charadrius vociferus* (Linn.), Kildeer Plover. Iona Is., 19 March 1933. C.H.B.

**Quadraceps nigrolimbatus** (Mjoberg), 1910.
**Limnodromus griseus* (Gmelin), Dowitcher. Iona Is., 9 April 1932. C.H.B.; Goose Is., 23 July 1948. C.J.G.

**Ouadraceps normifer** (Grube), 1851.
*Stercorarius longicaudus* (Vieillot), Long-tailed Jaeger. Churchill, Man., 4 July 1947 and July 1948. M.Y.W., G.J.S.
*Stercorarius parasiticus* (Linn.), Parasitic Jaeger. Churchill, Man., 4 July 1947. M.Y.W.; Goose Is., 14 Aug. 1948. C.J.G.

**Quadraceps obliquus** (Mjoberg), 1910.
*Uria aalge* (Pontoppidan) (Uria troille), Common Murre. Vancouver, 6 Feb. 1950. G.J.S.

**Quadraceps ornatus ornatus** (Grube), 1851.
*Larus canus* Linn., Short-billed Gull. Vancouver, 17 Jan. 1948. G.J.S. Five other records, Vancouver area and Victoria, 1932 to 1941. C.H.B., I.McT.C. and G.J.S.

**Quadraceps ornatus** (Grube), 1851.
*Larus glaucescens* Naumann, Glaucous-winged Gull. Bella Bella, 18 March 1933. C.H.B.

**Quadraceps sellatus** (Burmeister), 1838.
*Sterna hirundo* **(Linn.)**, Common Tern. Vernon, Sept. 1934. E.R.B.

**Quadraceps similis** (Giebel), 1866.
**Totanus melanoleucus* (Gmelin), Greater Yellow-legs. Lulu Is., Vancouver, 19 April 1932. K.R.; Goose Is., 23 July 1948. P.W.M.

**Quadraceps stillaepolaris** Timmermann. Recent name.
*Stercorarius pomarinus* (Temminck), Pomerine Jaeger. Goose Is. Banks, 27 July 1948. P.W.M.

**Rallicola** sp. Det. K.C.E.
*Porzana carolina* (Linn.), Sora Rail. Watson Lake, 20 July 1949. G.J.S.

**Rhynonirmus scolopacis** (Denny), 1842.
*Capella gallinago* (Linn.), Wilson Snipe. Vancouver, 12 Nov. 1953. G.J.S.

**Saemundssonia calva** (Kellogg), 1896.
*Uria aalge* (Pontoppidan) (Uria troille), Common Murre. Vancouver, 6 Feb. 1950. G.J.S.

**Saemundssonia cephalus** (Denny), 1842.
*Stercararius parasiticus* (Linn.), Parasitic Jaeger. Churchill, Man., 4 July 1947. M.Y.W.

**Saemundssonia kratachvili** Balat. Recent name.
*Capella gallinago* (Linn.), Wilson Snipe. Vancouver, 12 Nov. 1953. G.J.S.

**Saemundssonia laria** (O. Fabricius), 1870.
*Larus argentatus* (Pontoppidan), Herring Gull. Enderby, 12 Nov. 1951. J.W.
*Larus californicus* (Lawrence), California Gull. Riske Creek, Chilcotin, 28 Sept. 1951. L.J.
*Larus canus brachyrhynchos* Richardson. Short-billed Gull. Iona Is., 5 Feb. 1933. C.H.B.
*Larus glaucescens* Naumann. Glaucous-winged Gull. Vancouver, 9 Jan. 1948. K.R.
*Larus hyperboreus* (Gunnerus), Glaucous Gull. 15 April 1932. R.A.C.
*Larus philadelphia* (Ord), Bonaparte Gull. Vernon, Sept. 1934. E.R.B.; Sea Island, 8 May 1942. R.A.C.

**Saemundssonia lockleyi** Clay, 1949.
**Sterna paradisaea* Pontoppidan, Arctic Tern. Aklavik, N.W.T., 5 July 1947. I.McT.C.

**Saemundssonia montereyi** (Kellogg), 1896.
*Synthliboramphus antiquus* (Gmelin), Ancient Murrelet. Vancouver, 17 Nov. 1947. G.J.S.

**Saemundssonia naumanni** (Giebel), 1874.
*Squatarola squatarola* (Linn.), Black-bellied Plover. Vernon, 1 Jan. 1935. E.R.B.

**Saemundssonia platygaster** (Denny), 1842.
**Totanus flavipes* (Gmelin), Lesser Yellowlegs. Kamloops, 25 Aug. 1935. M.Y.W. and G.J.S.

**Saemundssonia s. scolopacisphaeopodis** (Schrank), 1803.
**Phaeopus (Numenius) hudsonicus* (Latham), Hudsonian Curlew. Lulu Is., Vancouver, 30 April 1941. I.McT.C. and G.J.S.

**Saemundssonia scolopacisphaeopodis humeralis** (Denny), 1842.
**Numenius americanus* (Bechstein), Long billed Curlew. White Lake, 1 June 1941. I.McT.C.

**Saemundssonia stresemanni** Timmerman, 1949.
**Stercorarius pomarinus* (Timminck), Pomerine Jaeger. Goose Is. Banks, 27 July 1948. P.W.M.
*Catharacta skua* Brunnich, Skua. Goose Island Banks, July 1949. I.McT.C.

**Saemundssonia tringae** ? subsp. (O. Fabricius), 1870.
*Erolia alpina* (Linn.), Dunlin, Red-backed Sandpiper. Lulu Is., Vancouver, 18 Nov. 1953. R.W. and G.J.S.
**Limnodromus griseus* (Gmelin), Dowitcher. Iona Is., 9 April 1932. C.H.B.
**Eureunetes mauri* Cabanis, Western Sandpiper. Goose Is., 10 July 1948. C.J.G.; Sea Is., Vancouver, 7 May 1949. K.R.

**Saemundssonia** Timmermann, 1935. sp.
*Erolia melanotos* (Vieillot), Pectoral Sandpiper. Iona Is., Vancouver, 19 March 1933. C.H.B.

**Strigiphilus ceblebrachys** (Denny), 1842.
*Nyctea scandiaca* (Linn.), Snowy Owl. Lumby, 24 Nov. 1946. J.G. Six other records, Vancouver area and Kamloops, 1929 to 1945, various collectors.

**Strigiphilus cursor** (Burmeister), 1838.
*Asio flammeus* (Pontoppidan), Short-eared Owl. Vancouver, 10 Feb. 1947. G.J.S.
**Asio otus* (Linn.), Long-eared Owl. Huntingdon, 18 Nov. 1952. G.J.S.

**Strigiphilus oculatus** (Rudow), 1870.
*Bubo virginianus* (Gmelin), Great Horned Owl. Vancouver, 14 Nov. 1947. G.J.S. Eleven other records from Coast to Dry Belt, 1933 to 1950, various collectors.

**Strigiphilus otus** Emerson 1955. PARATYPES, 4 slides.
*Otus asio* (Linn.), Screech Owl. Vancouver, 21 March 1932. R. A. Cumming; Vancouver, 10 Nov. 1948. G.J.S. Three slides.

**Strigiphilus speotyti** (Osborn), 1896.
*Speotyto cunicularia* (Molina), Burrowing Owl. Kamloops, 26 July 1936. M.Y.W. and 2 July 1934. G.J.S.

**Strigiphilus syrnii** (Packard), 1873.
**Strix occidentalis* (Xanthus), Spotted Owl. Vedder Crossing, Oct. 1940. I.McT.C. and G.J.S.

**Strigiphilus Mjoberg,** 1910. sp. ? **crenulatus** (Giebel), 1874.
*Surnia ulula* (Linn.), Hawk Owl. Williams Lake, 1 March 1944. L.J.

## HOST LIST WITH PARASITES

### Order PYGOPODES, Diving Birds

**Synthliboramphus antiquus** (Gmelin), Ancient Murrelet.
*Saemundssonia montereyi* (Kellogg).

**Uria aalge** (Pontoppidan), Common Murre.
*Austromenopon* Bedford, 1939, species being described.
*Quadraceps obliquus* (Mjoberg).
*Saemundssonia calva* (Kellogg).

### Order LONGIPENNIS, Long-winged Swimmers

**Catharacta skua** Brunnich, Skua.
*Saemundssonia stresemanni* Timmermann.

**Stercorarius pomarinus** (Timminck), Pomarine Jaegar.
*Perineus ? grandis* (Piaget).
*Quadraceps stellaepolaris* Timmermann.
*Saemundssonia stresemanni* Timmermann.

**Stercorarius parasiticus** (Linn.), Parasitic Jaegar.
*Quadraceps normifer* (Grube).
*Saemundssonia cephalus* (Denny).

**Stercorarius longicaudus** Vieillot, Long-tailed Jaegar.
*Quadraceps normifer* (Grube).

**Larus hyperboreus** (Gunnerus), Glaucous Gull.
*Saemundssonia lari* (O. Fabricius).

**Larus glaucescens** Naumann, Glaucous-winged Gull.
*Actornithophilus lari* (Packard).
*Austromenopon transversum* (Denny).
*Quadraceps ornatus* (Grube).
*Saemundssonia lari* (O. Fabricius).

**Larus argentatus** (Pontoppidan), Herring Gull.
*Saemundssonia lari* (O. Fabricius).

**Larus californicus** (Lawrence), California Gull.
*Austromenopon* Bedford, 1939. Sp. being described.
*Saemundssonia lari* (O. Fabricius).

**Larus canus** Linn., Short-billed Gull.
*Quadraceps ornatus ornatus* (Grube).
*Saemundssonia lari* (O. Fabricius).

**Larus philadelphia** (Ord.), Bonaparte Gull.
*Saemundssonia lari* (O. Fabricius).

**Sterna hirundo** (Linn.), Common Tern.
*Quadraceps sellatus* (Burmeister).

**Sterna paradisaea** Pontoppidan, Arctic Tern.
*Saemundssonia lockleyi* Clay.

### Order ANSERES, Lamellirostral Swimmers

**Cygnus buccinator** Richarson, Trumpeter Swan.
*Anastoecus cygni* subsp. (Denny).
*Ornithobius* Denny, sp.

### Order PALUDICOLAE, Marsh Birds

**Porzana carolina** (Linn.), Sora Rail.
*Rallicola* sp. Female.

### Order LIMICOLAE, Shore Birds

**Lobipes lobatus** (Linn.), Northern Phalarope.
*Quadraceps connexus* (Kellogg and Mann).

**Steganopus tricolor** Vieillot, Wilson Phalarope.
*Actornithophilus umbrinus* (Burmeister).
*Quadraceps fimbriatus* (Giebel).
**Capella gallinago** (Linn.), Wilson Snipe.
*Actornithophilus* Ferris, Sp. indet.
*Cummingsiella ambigua* (Burmeister).
*Rhynonirmus scolopacis* (Denny).
*Saemundssonia kratchvili* Balat.
**Limnodromus griseus** (Gmelin), Dowitcher.
*Quadraceps nigrolimbatus* (Mjoberg).
*Saemundssonia tringae* ? subsp. (O. Fabricius).
**Calidris canutus** (Linn.), Knot or Red-breasted Plover.
*Carduiceps zonarius* (Nitzsch).
*Lunaceps drosti* Timmerman.
**Erolia melanotus** (Vieillot), Pectoral Sandpiper.
*Actornithophilus umbrinus* (Burmeister).
*Carduiceps zonarius* (Nitzsch).
*Saemundssonia* Timm. sp. indet.
**Erolia minutilla** Vieillot, Least Sandpiper.
*Actornithopilus umbrinus* (Burmeister).
**Erolia alpina** (Linn.), Dunlin, Red-backed Sandpiper.
*Carduiceps meinertzhageni* Timmermann.
*Lunaceps actophilus* (Kellogg and Chapman).
*Saemundssonia tringae* ? subsp. (O. Fabricius).
**Ereunetes mauri** Cabinis, Western Sandpiper.
*Austromenopon* Bedford. Sp. being described.
*Carduiceps zonarius* (Nitzsch).
*Saemundssonia tringae* ? subsp. (O. Fabricius).
**Totanus melanoleucus** (Gmelin), Greater Yellow-legs.
*Actornithophilus totani* (Schrank).
*Quadraceps similis* (Giebel).
**Totanus flavipes** (Gmelin), Lesser Yellow-legs.
*Actornithophilus totani* (Schrank).
*Quadraceps falcigerus* (Peters).
*Saemundssonia platygaster* (Denny).
**Catoptrophorus semipalmatus** (Gmelin), Willet.
*Quadraceps carrickeri* Hopkins and Timmermann.
**Numenius americanus** (Bechstein), Long-billed Curlew.
*Cummingsiella longirostricola* (Wilson).
*Lunaceps numenii* (Denny).
*Saemundssonia scolapacisphaeopodis humeralis* (Denny).
**Phaeopus hudsonicus** (Latham), Hudsonian Curlew.
*Lunaceps phoeopi* (Denny).
*Saemundssonia s. scolapacisphaeopodis* (Schrank).
**Squatarola squatarola** (Linn.), Black-bellied Plover.
*Saemundssonia naumanni* (Giebel).
**Charadrius vociferus** (Linn.), Killdeer Plover.
*Actornithophilus ochraceus* Nitzsch.
*Quadraceps hiaticulae boephilus* (Kellogg).

Order GALLINAE, Gallinaceous Birds

**Gallus domesticus** (L), Common hen.
*Lipeurus caponis* (Linn.).
*Menacanthus stramineus* (Nitzsch).
*Menopon gallinae* (Linn.).
**Lophortyx californica** (Shaw and Nodder), California Quail.
*Goniodes stefani* Clay and Hopkins.
*Lagopoecus gambeli* Emerson.
**Phasianus colchicus** Gmelin, and subspp., Ring-necked Pheasant.
*Cuclotogaster heterographus* (Nitzsch).
*Goniodes colchici* Denny.
*Lagopoecus colchicus* Emerson.
*Lipeurus caponis* (Linn.).
*Lipeurus maculosus* Clay.
**Lagopus mutus rupestris** Gmelin, Rock Ptarmigan.
*Goniodes lagopi* (Linn.).
**Lagopus lagopus** (Linn.), Willow Ptarmigan.
*Lagopoecus affinis* (Children).
**Pavo cristatus** (Linn.) Peacock.
*Amyrsidea phaeostoma* Nitzsch.
*Goniodes pavonis* (Linn.).

Order COLUMBAE, Pigeons and Doves

**Columba fasciata** Say, Band-tailed Pigeon.
*Columbicola columbae* (Linn.).
*Coloceras (Goniodes) piageti* J. & H.
*Hoborstiella frontalis* Carricker.
**Columba** var. Domestic and Carrier Pigeons.
*Columbicola columbae* (Linn.).
**Zenadura macrura** (Linn.), Mourning Dove.
*Columbicola baculoides* (Paine).

Order RAPTORES, Birds of Prey

**Cathartes aura** (Linn.), Turkey Vulture.
*Colpocephalum kelloggi* Osborn.
*Cuculiphilus alternatus* (Osborn).
*Falcolipeurus marginalis* (Osborn).
*Laemobothrion canalense* Eichler.
**Accipiter striatus velox** (Wilson), Sharp-shinned Hawk.
*Nosopon lucidum* (Rudow).
**Accipiter cooperi** (Bonaparte), Cooper's Hawk.
*Colpocephalum impressum* Rudow.
*Craspedorrhynchus nisi* (Denny).
**Accipiter gentilis** (Linn.), Goshawk.
*Colpocephalum impressum* Rudow.
*Craspedorrhynchus haematopus* (Scopoli).
**Buteo swainsoni** (Bonaparte), Swainson's Hawk.
*Craspedorrhynchus platysomus* (Burmeister).
*Kurodaia* Uchida, 1926. sp. indet.
*Laemobothrion maximum* (Scopoli).
**Buteo lagopus** (Pontoppidan), Rough-legged Hawk.
*Craspedorrhynchus dilatatus* (Rudow).
**Aquila chrysaetos** (Linn.), Golden Eagle.
*Colpocephalum flavescens* (Haan).
**Haliæetus leucocephalus** Linn., Bald Eagle.
*Colpocephalum flavescens* (Haan).
*Craspedorrhynchus halieti* (Osborn).
*Laemobothrion* sp.
**Falco columbarius** (Linn.), Pigeon Hawk.
*Laemobothrion tinnunculi* (Linn.).
**Falco sparverius** (Linn.), Sparrow Hawk.
*Laemobothrion tinnunculi* (Linn.).
*Nosopon lucidum* (Rudow).
**Pandion haliaetus** (Linn.), Osprey.
*Kurodaia haliaeti* (Denny).

**Asio otus** (Linn.), Longeared Owl.
*Strigiphilus cursor* (Burmeister).
**Asio flammeus** (Pontoppidan), Short-eared Owl.
*Strigiphilus cursor* (Burmeister).
**Strix occidentalis** (Xanthus), Spotted Owl.
*Strigiphilus syrnii* (Packard).
**Cryptoglaux funerea richardsoni** (Bonaparte), Little Boreal Owl.
*Kurodaia* sp. indet.
**Cryptoglaux acadica** (Gmelin), Saw-Whet Owl.
*Kurodaia* sp. indet.
**Otus asio kennicotti** (Elliott), Screech Owl.
*Kurodaia cryptostigmatia* (Nitzsch).
*Strigiphilus otus* Emerson.
**Bubo virginianus** (Gmelin), Great Horned Owl.
*Kurodaia* sp.
*Strigiphilus oculatus* (Rudow).
**Nyctea scandiaca (Linn.), Snowy Owl.**
*Strigiphilus ceblebrachys* (Denny).
**Surnia ulula** (Linn.), Hawk Owl.
*Strigiphilus ? crenulatus* (Giebel).
**Speotyto cunicularia** (Molina), Burowing Owl.
*Strigiphilus speotyti* (Osborn).

Order MACROCHIRES, Nightjars, Swifts, Hummingbirds

**Nephoecetes niger** (Gmelin), Northern Black Swift.
*Dennyus spiniger* Ewing.
*Eureum spenceri* Emerson and Pratt.

Additional Records, received after the previous list.

## MALLOPHAGA AND HOSTS

**Austromenopon alpinum** Zimmermann, 1954.
*Erolia alpina* (Linn.), Dunlin, Red-backed Sandpiper. Vancouver, 18 Nov. 1953. R.W. and G.J.S.
**Austromenopon nigropleurum** (Denny), 1842.
*Synthliboramphus antiquus* (Gmelin), Ancient Murrelet. Vancouver, 17 Nov. 1947. G.J.S.
**Bruelia** Keler, 1936. Sp.
*Ixoreus naevius* (Gmelin), Varied Thrush. Vancouver, 13 Feb. 1943 and 18 Feb. 1949. G.J.S.
**Degeeriella d. discocephalus** (Burmeister) 1838.
*Haliaeetus leucocephalus* (Linn), Bald-headed Eagle. Univ. Campus, Vancouver, March, 1937. C.J.G. and G.J.S.
**Degeeriella fulva (Giebel)**, 1874.
*Buteo jamaicensis* (Gmelin), Red-tailed Hawk. Grindrod, 1 May 1949. J.W.
*Bueto lagopus* (Pontoppidan), Rough-legged Hawk. Fraser Valley, 21 Oct. 1952. G.J.S.
**Degeeriella fusca** (Denny), 1842.
*Circus cyaneus* (Linn), Marsh Hawk. Fraser Valley, 21 Oct. 1952. G.J.S.
**Degeeriella regalis regalis** (Giebel), 1866.
*Buteo swainsoni* (Bonaparte), Swainsons Hawk. Red Deer, Alta., 4 May 1938; Hillier, 28 May 1950. J.W.
**Degeeriella rufa carruthi** Emerson. Recent.
*Falco sparverius* (Linn), Sparrow Hawk. Univ. Campus, Vancouver, 22 April 1936. G.J.S.
**Degeeriella rufa rufa** (Burmeister), 1838.
*Falco peregrinus* Tunstall, Peregrine Falcon. Vancouver, 3 May 1936. K.R. and G.J.S.
**Falcolipeurus** Bedford, 1931.
*Haliaeetus leucocephalus* (Linn), Bald-headed Eagle. Kamloops, 9 Dec. 1933 (Per S. Keyes). G.J.S.
**Laemobothrion** Nitzsch, 1818 Sp. indet.
*Buteo jamaicensis* (Gmelin), Red-tailed Hawk. Armstrong, 6 Nov. 1947. J. Grant.
**Philopterus** Nitzsch, 1818, Sp. indet.
*Hylocichla ustulata* (Nuttall), Olive-backed Thrush. Vancouver, 24 May 1952. R.A.C.
**Philopterus** sp.
*Ixoreus naevius* (Gmelin), Varied Thrush. Vancouver, 13 Dec. 1945. G.J.S.
**Philopterus ? sialii** (Osborn), 1896.
*Sialia mexicana* Swainson, Western Bluebird. Grindrod, 17 May 1950. J.W.
**Quadraceps** Clay & Meinertzhagen, 1939. Sp. Indet.
*Brachyramphus marmoratus* (Gmelin), Marbled Murrelet. Vancouver, 17 Nov. 1947. G.J.S.
**Quadraceps** sp.
*Synthliboramphus antiquus* (Gmelin), Ancient Murrelet. Vancouver, 17 Nov. 1947. G.J.S.
**Saemundssonia** Timmermann, 1935.
*Fratercula corniculata* (Naumann), Horned Puffin. Paul Is., Alaska, 14 Aug. 1946. G.C.C.

## HOST LISTS WITH PARASITES

Order PYGOPODES, Diving birds

**Fratercula corniculata** (Naumann), Horned Puffin.
*Saemundssonia* sp.
**Synthliboramphus antiquus** (Gmelin), Ancient Murrelet.
*Austromenopon nigropleurum* (Denny).
*Quadraceps* sp.
**Brachyramphus marmoratus** (Gmelin), Marbled Murrelet.
*Quadraceps* sp.

Order LIMICOLAE, Shorebirds

**Erolia alpina** (Linn), Dunlin, Red-backed Sandpiper.
*Austromenopon alpinum* Timmermann.

Order RAPTORES, Birds of prey

**Circus cyaneus** (Linn), Marsh Hawk.
*Degeeriella fusca* (Denny).
**Buteo jamaicensis** (Gmelin), Red-tailed Hawk.
*Degeeriella fulva* (Giebel).
*Laemobothrion* sp.
**Buteo swainsoni** (Bonaparte), Swainson's Hawk.
*Degeeriella regalis regalis* (Giebel).
**Buteo lagopus** (Pontoppidon), Rough-legged Hawk.
*Degeeriella fulva* (Giebel).
**Haliæetus leucocephalus** (Linn), Bald-headed Eagle.
*Falcolipeurus* sp.
**Falco peregrinus** Tunstall, Peregrine Falcon.
*Degeeriella rufa rufa* (Burmeister), 1838.
**Falco sparverius** (Linn), Sparrow Hawk.
*Degeeriella rufa carruthi* Emerson.

Order PASSERES, Perching Birds

**Hylocichla ustulata** (Nuttall), Olive-backed Thrush.
*Philopterus* sp.

**Ixoreus naevius** (Gmelin), Varied Thrush.
*Bruelia* sp.
*Philopterus* sp.

**Sialia mexicana** Swainson, Western Bluebird.
*Philopterus ? sialii* (Osborn).

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4. Harrison, Launcelot. 1916 The Genera and Species of Mallophaga. Parasitol. 9(1).
5. Emerson, K. C. and Pratt, Harry D. 1956. The Menoponidae found on North American Swifts. J. Kansas Ent. Soc. 29(1).

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART V — *DIORYCTRIA* SPP. (PYRALIDAE)[1]

D. A. ROSS[2] and D. EVANS[3]

1. Contribution No. 295, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2 Forest Biology Laboratory, Vernon, B.C.
3 Forest Biology Laboratory, Victoria, B.C.

Snout moths of the genus *Dioryctria* (includes *Pinipestis*) are an important, although rather imperfectly known group of conifer pests. Their larvae attack cones, foliage, and the bark and outer wood of twigs or trunks. Larvae of most *Dioryctria* are drab and of uniform coloration. Some species have pigmented pinacula giving a spotted appearance; others have broad, and in some instances, obscure stripes. All members of the genus have a prominent, pale-coloured, black-ringed pinaculum above each spiracle on $A_8$, and an even more prominent, similarly marked pinaculum on the side of $T_2$. *Dioryctria* spp. over-winter in the larval stage; most of the boring species pupate in a silk-lined cell within the host plant tissue. Excepting *D. abietella* D. & S. which emerges in the spring, adults emerge during midsummer.

**D. auranticella** (Grote). *Pinus ponderosa* (cones and staminate flowers); Southern Interior. During 1949 to 1954, was in epidemic proportions through much of the Okanagan Valley; as many as 80 per cent of the cones from some sample trees were infested. Usually cones that have been attacked by this borer do not open. Infested cones have small, round, clean exit holes. Often several larvae feed in a cone leaving it a mere shell. This insect pupates in a silk-lined cell in the cone. **Larva:** length, 1 inch; head, reddish-brown and black; prothoracic shield and legs, black; body, blackish to dirty light brown, may be reddish tinge on thorax; suranal plate, anal prolegs, and circular spot on eighth abdominal segment, pale tan, the latter with narrow black border; brownish about setal bases.

**D.** sp. nr. **auranticella.** *Pinus ponderosa* (cones): Southern Interior; much less common than *auranticella*; habits similar to *D. auranticella.* **Larva:** $\frac{3}{4}$ inch; reddish-brown head; prothoracic shield, suranal shield and sides of anal prolegs pale tan; body flesh-coloured; subdorsal - supraspiracular stripe dark grey; pinacula not pigmented.

**D. abietella** D. & S. In the cones of *Pseudotsuga menziesii, Picea engelmanni, Abies lasiocarpa, Pinus ponderosa, Pinus contorta* (and from *Cronartium* gall on branch), *Pinus monticola* (from mechanically injured portion of bole); generally distributed throughout Interior B.C. Larva forms a mass of frass and castings about burrow entrance; the cone boring form overwinters on the ground as a fully developed larva in a silky cocoon coated with adhering bits of duff and soil. Douglas fir cones were infested lightly throughout much of the Southern Interior during 1950 and 1951, although the species was less numerous than *Barbara colfaxiana*. **Larva:** ¾ inch; head, reddish-brown, prothoracic shield paler; upper half of body, pinkish-red, rather obscure dark dorsal and subdorsal stripes; venter pale; suranal plate and centre of $A_8$ pale tan, speckled with brown.

**D. reniculella** Grt. complex. *Picea glauca, Picea engelmanni, Pseudotsuga menziesii, Abies lasiocarpa;* generally distributed. The form on spruce may be a species distinct from the fir feeders. *D. reniculella* is almost exclusively a needle feeder in British Columbia; only one adult was reared from a Douglas fir cone. No outbreaks recorded. **Larva:** ⅝ inch; head, tan to dark brown to black; prothoracic shield yellowish-tan; ground colour of body, pale yellow; upper portions of body, pale cinnamon, with faint yellowish dorsal and subdorsal stripes; dark brown patches or black stripe along supraspiracular area.

**D. zimmermani** (Grt.). *Pinus contorta* (bole and branches, and ex *Cronartium* sp. galls on branches); *Pinus monticola* (bole). This species is chiefly secondary and only occasionally is primary in British Columbia; generally distributed through the Interior. **Larva:** ¾ inch; head, reddish-brown, mouthparts, blackish; prothoracic shield dark brown; suranal plate pale tan; body, dirty off-white; blackish pinacula; irregular rows of minute black platelets on thorax and abdomen observable under magnification.

**D.** sp. nr. **zimmermani**. *Pinus ponderosa* (bole); Nicola R. Valley. Four adults were reared from the area surrounding a patch of rodent-damaged bark. **Larva:** unknown.

**D. cambiicola** Dyar. *Pinus ponderosa* (twigs); Okanagan Valley. A light infestation occurred in mature ponderosa pine, Summerland Experimental Farm, 1953-1954. The larvae bore into sides of twigs and feed on the bark and cambium of branchlets; their presence is indicated by a mass of pitch-coated frass and castings. The terminal portion of the infested branch dies. **Larva:** ¾ inch; head, reddish-brown, black about mouthparts; prothoracic shield, black; body, dirty white; blackish pinacula; under magnification, irregular rows of minute black platelets discernible on thorax and abdomen; centre of suranal plate and anal prolegs, reddish-brown or black.

**Acknowledgment and note**

The writers are indebted to Dr. E. Munroe for identifying adult material reared during investigations of the genus *Dioryctria*.

One change in a species name was made by the senior author after the paper was in press. This was done following a perusal of the newly released "American Moths of the Subfamily Phycitinae" by C. Heinrich. U.S.N.M. Bull. 207. 1956

## Gyrophaena Insolens Csy.

*Gyrophaena insolens* Csy. (Coleoptera: Staphylinidae). I took a good series of this insect at Creston, B.C., from a large yellow mushroom, 9-IX-1951. By that time Seevers' *Revision of Gyrophaena* was already in press, so my capture was too late to receive notice. But in his letter identifying the species Seevers mentioned he had seen only three or four specimens of *insolens*, these from the type locality, Isle Royale, Michigan. The Revision lists five species from B.C., all of which I have: *affinis* Sahlb., *uteana* Csy., *keeni* Csy., *californica* Csy. and *nana* Payk. But *insolens* is larger and more distinctive than any of these.—*G. Stace Smith, Creston, B.C.*

# NOTE ON DAMAGE TO LEAD CABLE BY THE BROWN HOUSE MOTH, *HOFMANNOPHILA PSEUDOSPRETELLA* (STAINT). (LEPIDOPTERA: OECOPHORIDAE)[1]

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In August, 1955, a damaged section of lead sheathing (Fig. 1) from an interphone cable was sent to the Vancouver laboratory by a local pest control operator. The metal, 0.06 in. thick, was pitted and perforated. Microscopic examination revealed minute, gnawed marks lining the small pits and perforations. These marks appeared to have been made by the mandibles of insects, since they were much too fine to have been made by a rodent's teeth. The pest control operator stated that the cable came from a local race track, where it formed part of the totalizator equipment.

The author then examined the equipment at the race track. The betting wickets were under the grandstand of the race track. The cables were confined to the floor area behind and along the length of the series of wickets, and connected the ticket-issuing machines with the master control panel in the grandstand and the totalizator board in the infield of the race track. The cables, of various sizes and covered with pure lead, were enclosed for protection by a wooden casing, in which the pest control operator had placed rat bait at various points. Damage to the cables was confined to areas beside the bait. which contained corn meal, oats, and 0.025% warfarin. Apparently fresh bait had been regularly added with little effort to remove old, insect-infested material. The baiting had been conducted for at least eighteen months before the damage was noticed.

Adults of the brown house moth, *Hofmannophila pseudospretella* (Staint.), were present in the wooden casing. The bait contained larvae, webbing, frass, and pupal cases of this moth. Larvae had spun cocoons along the cable within the piles of bait, and microscopic examination revealed minute particles of lead incorporated among the webbing of the pupal cases around the points of attachment to the cable. Large white pellets of frass around the pupal cases contained minute pieces of lead, which appeared to have passed unchanged through the alimentary canal. The size of these pellets and the presence of lead in the pupal case webbing suggested that the damage was caused by late-instar larvae.

The damaged areas were repaired satisfactorily by re-leading. The wooden casing was thoroughly cleaned. vacuumed, and sprayed with resi dual insecticide to lessen the likelihood of repetition of the damage.

The moth is a pest of stored foodstuffs in British Columbia. It has been taken in cereal warehouses and feed plants in cities on Vancouver Island and in the Okanagan Valley in the interior of the province. It has been found in Vancouver feed warehouses and terminal elevators. In the latter, they are most abundant in the workhouse basements and in the basement tunnels, where the humidity is high and the temperature fairly stable. In the basements they feed on dust and grain spillage. The moth is occasionally found in Vancouver homes. Dead insects and spider's webs are the insect's food in unheated buildings such as garages and sheds. The moth was probably established in the grandstand on such a diet when it spread to the rat bait. So far as known, this is the first record of damage to lead by the larvae of the brown house moth.

1 Contribution No. 3447, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.

2. Officer-in-Charge.

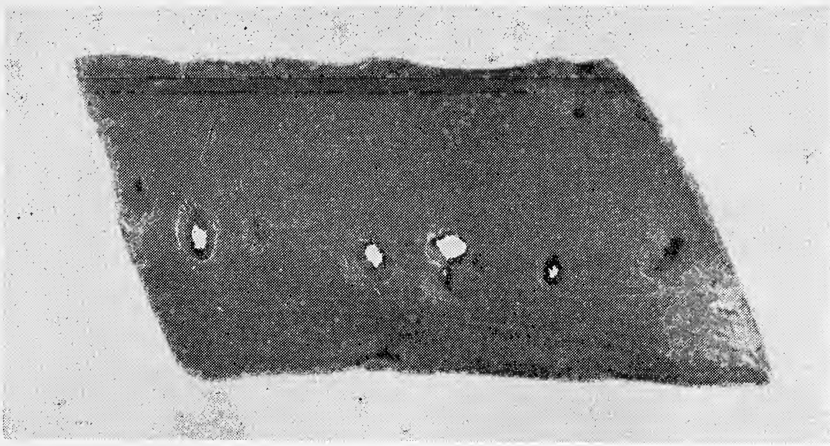

Fig. 1.—Section of lead sheathing showing damage caused by larvae of *Hofmannophila pseudospretella* (Staint.).

**Lice on a Bald-headed Eagle**

On several occasions I have received from collectors a few specimens of a very small Mallophagan, *Colpocephalum flavescens* Hann, 1829, which is a normal louse of the bald-headed eagle. In 1947 Mr. Charles Guiguet of the Provincial Museum, Victoria, sent me one specimen of a magnificent louse 9½ mm. long taken from an eagle collected at Graham Island, Queen Charlotte Islands. This specimen was placed by Miss Theresa Clay of The British Museum in the genus *Laemobothrion,* species undetermined. Dr. K. C. Emerson of Oklahoma who has probably the second largest collection of Mallophaga in the world, told me that a *Laemobothrion* from bald-headed eagle had yet to be described.

On 1 February 1956, Provincial Game Inspector C. E. Estlin of Courtenay, Vancouver Island, sent in to the Dept of Zoology a young bald-headed eagle which he had confiscated from a citizen. The bird was afflicted with a rough, cancerous growth on the neck and at the base of the bill and must have been quite sickly to have had been killed with a shotgun; normally one does not get close enough to an eagle to collect it with a shotgun. I have always found that sickly animals have more ectoparasites on them than healthy ones. Certainly in this instance never was sickness in a bird more profitable.

The outside of the paper wrappings that were around the eagle were crawling with lice, and from the bird itself I recovered about two cubic centimetres of *C. flavescens* after which I grew tired of picking them off the eagle, off myself, and for the next three days, off my laboratory coat.

Besides the small living lice, there dropped off the bird three dead specimens of *Laemobothrion.* Immediately the eagle was ruffled and brushed over to the last feather until no more large lice could be found. No less than 42 adults of both sexes and nymphs were obtained, females greatly predominating. If this is indeed a new species, the University will have a fine series of paratypes.—*G. J. Spencer, University of British Columbia.*

**Platynus Retractus (Lec.)**

*Platynus retractus* (Lec.) (Coleoptera: Carabidae). In *The Beetles of the Pacific North-West* Hatch mentions this species (p. 145), but could find no definite proof of its occurrence in our fauna, so "It is for the time being excluded from the Northwest list". But I have three specimens from Creston, B.C., verified by Lindroth. They are closest to *gratiosus* Mann., but are smaller, more ovate, antennae paler and with other minor distinctions, and are recognizable on sight. Most records of *retractus* are Eastern, but Carr has it on the Alberta list and it is known from Montana.—*G. Stace Smith, Creston, B.C.*

# OCCURRENCE OF *TRIRHABDA PILOSA* BLAKE (COLEOPTERA: CHRYSOMELIDAE) ON SAGEBRUSH IN BRITISH COLUMBIA, WITH NOTES ON LIFE-HISTORY[1]

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During August, 1954, Mr. W. L. Pringle, Agronomist, Canada Range Experimental Farm, Kamloops, B.C., observed severe defoliation of sagebrush, *Artemisia tridentata* Nutt., infested with insect larvae in a tract of range land six miles west of the city and three miles south of the Thompson River. Adults collected by Dr. R. H. Handford, Officer-in-Charge of the Kamloops Laboratory, were identified by Mr. R. de Ruette, Entomology Division, Ottawa, as chrysomelid beetles, *Trirhabda pilosa* Blake.

When Blake (1931) described this species she recorded it from Nevada, Wyoming, and California and listed *A. tridentata* Nutt. as a host. At the time the Kamloops specimens were identified it appeared that they constituted a new record of distribution. However, the author was informed (in litt.) by Mr. G. Stace-Smith, Creston, B.C., that his correspondence with Mrs. Blake during 1954 revealed she had, since 1931, obtained Alberta specimens, but she gave no locality or date. The author has been informed (in litt.) by Mr. W. J. Brown, Entomology Division, Ottawa, that in the Canadian National Collection, there are specimens of *pilosa* Blake from Seton Lake, Nicola, and Summerland, British Columbia. These records show that the species is found in a considerable area in the central portion of the southern interior of the province.

At Kamloops the beetle is of particular interest because of its apparent effect on sagebrush. Sagebrush is regarded as a pest plant in range land over much of the southern interior of British Columbia and some workers concerned with range management believe that elimination of sagebrush would greatly facilitate measures for improvement of range grasses. Hence the feeding habits of the beetle have aroused interest in the possibility of biological control of sagebrush.

The infestations first found by Mr. Pringle were in two stands of sagebrush, each covering 60 to 80 acres, at an elevation of 3000 feet in open range land. Pringle (1955) reported his observations on beetle infestations and damage to sagebrush as follows: "During September 1954, the beetles driven back by lack of food, flew out from the original location and were found over the entire area up to two miles away.

"In 1955, observations were again made and it was found that the larvae were present in large numbers covering over 2000 acres of sage land. They were sufficiently numerous to cause great harm to the sage. It is predicted that over 80% of the shrub so affected will die similar to the sage where the beetles were first discovered. In that location all but those plants that were used by ants as aphid pasture are now dead. The release of grass due to reduced competition by the sage is most marked and it is easy to see the increased grazing capacity which will result if this beetle is successful in controlling big sagebrush."

In the late summer of 1954 the author and Dr. Handford observed that some sagebrush plants in the infested stands were devoid of foliage and appeared dead. During the summer of 1955 the author and various

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2 Associate Entomologist.

officers of the Kamloops laboratory observed that some of the plants that appeared dead in 1954 did not produce foliage in 1955. These observations, along with the presumption that the same plants may have been defoliated by beetles in 1953 and perhaps earlier, suggested that successive defoliation for several seasons had caused death. Dissection of stems and branches of plants that produced no leaves in 1955, however, showed that the cambium layers contained some sap. Although dead or dying plants appeared to be directly associated with successive beetle infestations, the author and his laboratory associates consider that further study of the effects of defoliation is necessary.

Blake (1931) did not record the life-history of this species. Studies made by the author during 1954 and 1955 revealed the following details of life-history of the beetle as it occurs on sagebrush at Kamloops. The beetle has one generation per season and the winter is passed in the egg stage. Oviposition occurs from late July through August and may continue later as evidenced by the presence of fully developed eggs in females collected as late as September 23 in 1955. The eggs are irregularly oval in form, about 1 mm. long, with tough, leathery shells. They are laid singly or in adhering clusters of 2 or more and are deposited below host plants among debris on the ground surface or in the soil at depths of one-quarter to one inch. Hatching occurs from late May through June. In 1955 hatching was well under way by June 21, when larvae were abundant on host bushes.

Newly hatched larvae crawl up the trunks of bushes and disperse to the fresh, tender growth at the tips of branches, where, in the earlier larval stages, most feeding is done. As the lavae become larger and the foliage of branch tips is consumed, they move downward and, on heavily infested bushes, feed on all the foliage. Mature larvae are about half an inch long and bluish-black with a metallic lustre. On reaching maturity, they crawl down the bushes and concentrate in the debris and soil at the bases of plants, where they pupate. In 1955 larvae continued feeding through the latter half of June and through July, the peak of feeding occurring in the last week of June and the first week of July.

Movement of mature larvae to the soil was well underway by July 6 in 1955, and a week later pupae were plentiful below bushes that had been heavily infested. The pupae lie naked in the debris or soil, none being noted in earthen cells as reported by Blake (1931) to be characteristic of other species in the genus. The pupal stage lasts one to two weeks. Mature larvae caged on sagebrush at the laboratory on July 13 had stopped feeding by July 21 and entered the soil, by which date some had pupated. The first adults emerged from these pupae on July 29. In the infested stands of sagebrush a few adults were first noted on July 28, after which emergence greatly increased; heavy infestations of adults persisted throughout August. Adult populations apparently die out gradually through September. In 1954 a few active adults were seen on bushes as late as October 26.

## References

Blake, Doris H. 1931. Revision of the species of beetles of the genus *Trirhabda* north of Mexico. Proc. U. S. Nat. Mus. 79 (2).

[Pringle, W. L.] 1955. Sagebrush killed by beetle. Research Roundup 1 (1) :3. Canada Dept. Agr., Range Experimental Farm, Kamloops, B.C. (processed).

# NOTES ON A VARIETY OF THE WESTERN TENT CATERPILLAR, *MALACOSOMA PLUVIALE* (DYAR)[1]

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The typical form of the western tent caterpillar, *Malacosoma pluviale* (Dyar), is distributed across southern British Columbia from Vancouver Island to the Alberta boundary; the northern extremity of its range in the province is not yet definitely known, but it does not appear to be very far north of Kamloops.

A variety of the western tent caterpillar occurs over a large part of central and northern British Columbia, its range according to present knowledge being widely separated from that of the southern form (see map, Fig. 1). In 1947, the Forest Insect Survey at Vernon first received cocoons of this variety from Aleza Lake; since then material has been collected at many localities from the vicinity of Quesnel northward to Fort Nelson and from a point 50 miles east of Prince George westward to Fort Fraser.

## The Adult

The adult, according to Dr. E. Munroe of the Systematics Unit, Division of Entomology, Ottawa, cannot certainly be separated from typical *M. pluviale,* although the majority of specimens differ in coloration.

## The Egg Mass

Eggs have been examined in only two localities. The masses were in the form of a band encircling the twig in contrast to those of *M. pluviale* in southern British Columbia, which usually do not form a complete band. Although found only within two feet of the ground, the egg masses were on small twigs and not on main branches.

## Hosts and Habitat

The western tent caterpillar in the southern interior of British Columbia prefers trees and shrubs of the family Rosaceae; chokecherry, *Prunus virginiana,* saskatoon, *Amelanchier* spp., and wild rose, *Rosa* spp. are favoured hosts, and in the South Okanagan and East Kootenay districts, light infestations have been observed on antelope bush, *Purshia tridentata.* Willows, *Salix* spp., and mountain alder, *Alnus tenuifolia,* are often defoliated. The northern variety, however, as shown by the records of the Forest Insect Survey and numerous field observations, is not so general a feeder. The only hosts on which it has been known to develop infestations are dwarf birch, *Betula glandulosa* and one or two species of willows that grow in association with that shrub. This preference has resulted in a restricted habitat, that of muskegs, grassy swamps, and rarely, stream and lake margins. The muskeg type of habitat is found in many localities along the Hart Highway north of Prince George, and a number of minor infestations were observed there in the years 1950 to 1955. One of the most remarkable features of the insect is its abundance in these swamps where frequently the food plants are surrounded by water during the feeding period, and its absence from the intervening upland forest where most of the hosts acceptable to the southern form grow in profusion.

## The Larva

The basic colour pattern of the larva is similar to that of the typical form but black predominates and may, in some individuals, almost entirely replace the orange markings. A small proportion of most populations, however, may bear a conspicuous orange pattern resembling that of

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2 Forest Biology Ranger.

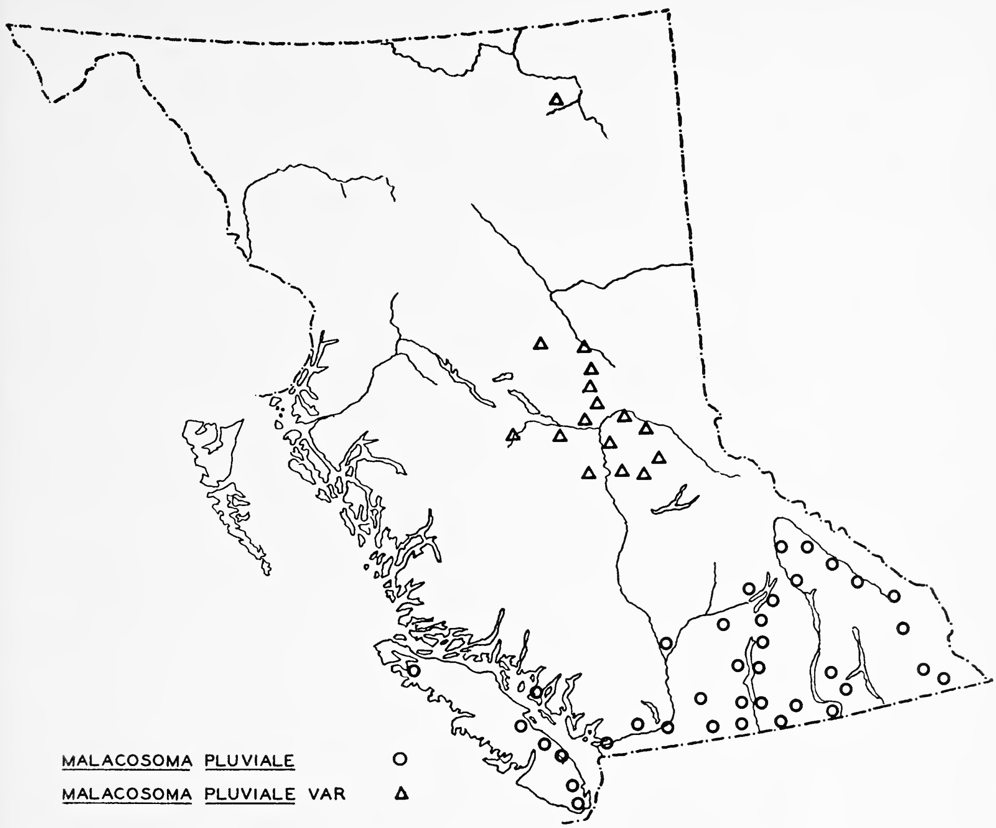


Fig. 1.—Distribution of collections and field observations of the western tent caterpillar, *Malacosoma pluviale* (Dyar), and a variety, in British Columbia.

larvae from the southern Interior. The habits are orthodox; each colony remains near the tent until growth is almost completed or the food supply exhausted. When this occurs, the larvae may migrate from a swamp and denude deciduous growth along the fringe of the surrounding forest.

**TABLE I.—Results of Dissection of 118 Cocoons of a Variety of *Malacosoma pluviale* Dyar, Hixon, B.C., July 8, 1950.**

| No. of pupae per cocoon | No. of cocoons | Total No. of pupae | No. of dead pupae | | Number of pupae surviving |
|---|---|---|---|---|---|
| | | | caused by parasitism* | caused by other factors | |
| 1 | 83 | 83 | 57 | — | 26 |
| 2 | 23 | 46 | 35 | 1 | 10 |
| 3 | 6 | 18 | 14 | — | 4 |
| 4 | 3 | 12 | 10 | — | 2 |
| 5 | 2 | 10 | 9 | — | 1 |
| 6 | 1 | 6 | 4 | 1 | 1 |
| Total | 118 | 175 | 129 | 2 | 44 |
| | | | 131 | | |

*Mortality from parasitism in all instances was caused by dipterous parasites.

Larval development is similar to that of the forest tent caterpillar, *Malacosoma disstria* Hbn., and the earliest recorded cocooning date for both species in the Quesnel district is June 9.

### The Cocoon

When cocoons of this variety were first collected at Aleza Lake in 1947, it was found that frequently two or more larvae had spun up together, uniting their efforts to form a single cocoon. The pupae were in a single envelope with no silk separating them. In 1950, a high population overflowed from a bog near Hixon and spun up in the surrounding forest, thus affording an opportunity to gather additional information on the frequency of multiple cocoons. The tops of five lodgepole pine saplings were clipped off and the masses of cocoons on the branches and leaders were dissected and the number of pupae in each recorded (Table 1).

## OCCURRENCE OF *LEPTOCONOPS KERTESZI* KIEFFER (DIPTERA: CERATOPONGONIDAE) IN BRITISH COLUMBIA[1]

L. COLIN CURTIS[2]

Veterinary and Medical Entomology Section, Entomology Laboratory, Kamloops, B.C.

At about noon on June 22, 1955, on a hot, dry, grassy slope along the Dog Creek — Gang Ranch cutoff in the southern Cariboo country, a horde of minute flies appeared, biting fiercely in the hair and ears of a party of entomologists. The attack was similar to that of no-see-ums (*Culicoides* spp.), but the latter usually bite at dusk and under conditions of shade and high humidity.

Specimens collected were identifiied by the writer as of *Leptoconops kerteszi* Kieffer. This species has an unusual distribution. The type locality is Cairo, Egypt, and specimens are recorded from elsewhere in Egypt and Tunisia, as well as from Cape Province in South Africa. On this continent they have been captured in Utah and California. Carter (1921), in his revision of the genus, stated that the Utah specimens had spherical spermathecae in contrast to the obovate form in the type, and tentatively named the variety *americanus* to accommodate them. However, the British Columbia specimens have distinctly obovate spermathecae.

This occurrence constitutes the first biting record for the species in Canada, although Mr. J. A. Downes, Entomology Division, Ottawa, stated (in litt.) that adults of *Leptonconops* sp. have been captured in southern Manitoba and Saskatchewan, and at Churchill, Man. In view of this wide distribution, the lack of earlier biting records is remarkable. It is possible that attacks by *Leptoconops* spp. have been attributed to *Culicoides* spp.

Carter set the range limits of the genus as between Lats. 35°S. and 40°N., with records all the way from North Africa to Siam and Queensland in the Old World, and in the United States, Cuba, and Brazil in the New. Since then there have been two records from France (Roman, 1937; Huttel and Huttel, 1952), one from the far eastern U.S.S.R. (Gutsevitch, 1947), and one from Washington State (Bacon, 1955). These, together with the new Canadian records, show the genus to have a cosmopolitan rather than a holotropical distribution.

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2 Assistant Entomologist.

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## BROCHOSOMES ON CERTAIN SPECIES OF INSECTS OF WESTERN NORTH AMERICA

*By* W. H. A. Wilde[2] and G. W. Cochrane[3]

Some unusual sponge-like bodies of insect origin were noted and photographed by Cochran in 1948 while he was making electron-microscope examinations of leafhopper body fluids. Tulloch, Shapiro, and Cochran (1) published the first description of these bodies. Tulloch and Shapiro (2) named them brochosomes, extended the known geographic and species range of insects known to have brochosomes, and described what they considered to be developmental forms.

Brochosomes appear as hollow spheroids with perforated external surfaces, varying in diameter from 240 to 600 millimicrons. Apparently non-living, they may be found singly or joined together in large masses by what appear as single or double strands. The chemical composition and function of brochosomes are unknown.

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3 Associate Research Professor, Department of Botany and Plant Pathology, Utah State Agriculture, College, Logan, Utah, U.S.A.

In studies at the Utah State Agricultural College brochosomes were found on the external surfaces of several species of Western North American insects. The specimens were placed in drops of ten per cent alcohol, and gentle manipulation of external surfaces of the insects usually dislodged an abundance of brochosomes which were readily observed when portions of the drops were transferred with micropipettes to standard specimen screens covered with Formvar membranes.

Brochosomes were found on external surfaces of adults of the following species of leafhoppers: *Circulifer tenellus* (Baker), *Dikraneura absenta* DeL. and Cl., and *Macrosteles fascifrons* (Stal.). Specimens of *M. fascifrons* and *D. absenta* tested were collected in two widely separated areas, Logan, Utah, and Creston, British Columbia. All specimens of *C. tenellus* tested were collected in Logan, Utah.

An attempt was made to obtain samples of internal body fluids free

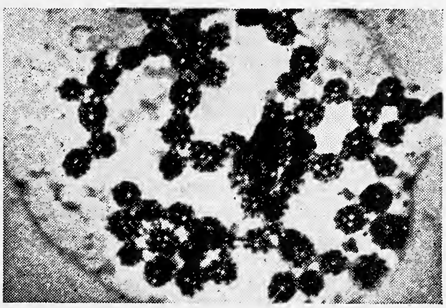

Fig. 1.—Unshadowed electron micrograph of brochosomes, approximately X8,000.

of contamination from the external surfaces of the insects. Capillary tubes drawn to extremely fine diameters were used to penetrate the exoskeleton of abdominal areas, and the body fluids that entered the tubes were then applied to the membrane-covered copper screens for electron microscope examination.

Studies were made of all stages of *C. tenellus*, the beet leafhopper. No brochosomes were found within the egg although they occurred on external surfaces of the egg. Some were found in internal body fluids and on external surfaces of the first, second, third, and fourth instars.

Brochosomes were also found on external surfaces of *Drosophila melanogaster* Mg. and *Musca domestica* L. None were found in the body fluids of these species, nor were they found externally on or internally in *Apis mellifera* L., *Vespula arenaria* (Fab.), *Leptocoris trivittatus* (Say), or *Myzus persicae* (Sulz.). Specimens of the last six species tested were collected near Logan, Utah.

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## Inversion of a fly pupa in a puparium

Early in June 1956 a few score maggots were picked up off the floor outside a preparation room where a number of heads of sea lions from the Queen Charlotte Islands were awaiting preparation for the departmental collection of skulls. The maggots were placed over clean sand in a rearing cage, and in from 10 to 12 days large blow flies *Cynomyopsis cadaverinus* (R. D.), emerged. In my limited experience, this is a northern fly or one of higher altitudes which rarely or never occurs as far south as Vancouver.

When the sand was sifted for pupae for pinning, one puparium was found with the two halves of the capitulum slit open a little way but still adherent and four actively kicking fly legs protruding. The puparium was chipped open very carefully, revealing an active but very malformed fly lying completely reversed, its head lying in the rounded spiracular caudal end of the puparium. The head was swollen, with the ptilinum extruded, rounded and dried; the antennae were depressed into the antennal grooves: only the eyes were completely formed; the first pair of legs was squeezed up against the thorax and the second and third pairs were sticking out behind; the wings were dried in the folded pupal condition.

The fly *C. cadaverinus* is remarkably large in proportion to its mature maggot, and the pupa normally occupies the whole of the coarctate puparium with little room for movement, let alone turning. How then did the fly become reversed end for end in the puparium and when did the reversal take place?—*G. J. Spencer, Unniversity of B.C.*

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## Patrobus Lecontei Chd.

*Patrobus lecontei* Chd. (Coleoptera: Carabidae). In the summer of 1956 Prof. Carl Lindroth and Dr. Geo. Ball collected through the Crows Nest Pass, B.C., ending up at Creston, where they spent a few days with me. At Cranbrook they had taken several *Patrobus lecontei*, a new record for the Province. They gave me directions to the exact spot of their captures, so I took the first opportunity (12-VIII) to visit it, and in two hours collected 23 specimens. The exact spot is a patch of bulrushes to the left of the main highway on the western approach of the town, and a few yards from the sign: "Entering Cranbrook", and the beetles were on the muddy margins of the bulrushes. With their bright reddish legs *lecontei* stand out sharply beside our other species of *Patrobus*. In his revision, *The American Patrobini*, 1938, Darlington lists the species from Newfoundland, Manitoba, Alberta and Colorado.—*G. Stace Smith, Creston, B.C.*

# NORTH AMERICAN BEETLES INFESTING MAMMALS

G. J. Spencer

University of British Columbia

In Leng's Catalogue of the Coleoptera of North America, the superfamily Staphylinoidea starts with three small families listed just before the Silphidae, namely: the Platypsyllidae, the Brathinidae, and the Leptinidae. The Brathinidae as far as known, occur in leaf mould; the other two families are ectoparasites on rodents.

In 1949 Mr. George Hopping published a short article in the Proceedings of our Society, Vol. 45, discussing some of these beetles and emphasizing the fact that four of the five species recorded from North America, are in the collection of the University of British Columbia. In September 1955, in the Annals of the Entomological Society of America appeared an article by Messrs. James R. Parks and John W. Barnes, titled "Notes on the Family Leptinidae including a new record of *Leptinellus validus* (Horn.) in North America (Coleoptera)" in which is mentioned *Platypsyllus castoris* together with a full discussion of the known species in the family and the approximate numbers in the collections of North American institutions.

To enlarge upon G. Hopping's article and to add a little to that of Parks and Barnes, I submit the following records of these three families which are represented in the University collections I have built up during the last 30 years.

The **Platypsyllidae** contains only one species, *Platypsyllus castoris* Ritsema, about 2 to 2.5 mm. long, found only on beaver and probably agreeing with the world distribution of that animal. Our records include:

One, on a point, labelled "C. W. Leng collection." Dakota, no date.

Three, on points, collected by R. Cliffe at Courtenay, B.C., 13 Jan. 1947.

Two, on points, collected by L. G. Sugden at Courtenay, B.C., 24 Sept. 1949.

Thirteen, on points, collected by G. J. Spencer at Courtenay, B.C., 13 March 1953.

Nineteen, in alcohol, Courtenay, 26 June 1949, from kit beaver with 8 larvae from the same animal. From L. G. Sugden.

Of the family **Brathinidae,** with three species recorded from North America, we have one specimen 3.3 mm. long, *Brathinus varicornis* Lec. labelled "Framingham, Mass. 11 Nov. 1939. C. A. Frost coll. sifting." This specimen is probably a gift from G. Hopping contributed at the time he arranged our beetle collection in 1946/47.

Of the family **Leptinidae,** Parks and Barnes give the world distribution of all known species. In 1866 Leconte named a North American beetle *Leptinus americanus.* Later this species was synonymized with a European form, *L. testaceus* Müller, 1817, which was considered to be holarctic. In 1948 Werner and Edwards removed *americanus* from synonomy with *testaceus* and established it as a valid Nearctic species (Parks and Barnes, *loc. cit.*). Although G. Hopping recorded our material as *testaceus,* it is in fact *americanus.* The family Leptinidae according to Parks and Barnes, contains only six valid species named so far; one Palearctic, one in Russia, one in Algeria and three in North America; we have all three North American species. Our records of *L. americanus* include:

One, on a slide, collected by J. D. Gregson at Silver Creek, Fraser Valley, B.C., 26 April 1940, from *Sorex* sp.

One, on a point, collected by G. J. Spencer at the University campus, 24 March 1945 from *Microtus serpens*, Merr.

One, on a point, collected by a student at 4200 ft., Silverhill mine, Tulameen, B.C., 12 Aug. 1955, from *Sorex* sp. This man, a student taking his doctorate in wild life management at this University, told me that the beetle was common on a number of small rodents that he had trapped in 1955, but since he was interested only in fleas, lice and ticks he discarded the beetles. He is working in the same territory this summer, 1956, and has promised to keep for me all that he collects. This species is supposed to be a nest inhabitant, but all our specimens have been taken from the fur of their hosts.

The main beaver parasite in this Province seems to be *Leptinellus validus* (Horn) or a species so labelled by G. Hopping. All our specimens are from 4 to 4.2 mm. long. Resembling young cockroaches in shape, they are in that respect like other members of this family, although not so flat. They are much darker coloured. The elytra are tightly locked together, or fused on the meson. In general they agree with Park's and Barnes' description, quoted from Jeannel, 1922. Records include:

One, on a point, collected with seven larvae at Lempriere, B.C., 15 May 1944, by O. French.

Twenty-one, on points, collected by Game Warden E. Holmes at Bowron Lakes, 10 Sept. 1949.

Forty-five, in alcohol, same date, place and collector, making 67 specimens of this species.

Finally, the third North American species *Leptinus* (*Leptinellus*) *aplodontiae* Ferris 1918, is specific to the mountain beaver *Aplodontia* sp. Our record is:

Four specimens on one slide, 2 males and 2 females, collection by Dr. C. Andresen Hubbard at Fort Dick, California, 8 Aug. 1943 from *Aplodontia pacifica*.

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## SOME RECORDS OF CERCERIDAE FROM BRITISH COLUMBIA
### (*SPHECOIDEA* : *HYMENOPTERA*)

G. J. SPENCER

Department of Zoology, University of British Columbia

Continuing the task of getting named the insects of this Province, which I have collected for the University over the years, I assembled the sphecoid wasps Cerceridae and sent them to Professor Emeritus Herman A. Scullen of Oregon State College who had volunteered to name them. I am deeply indebted to Professor Scullen who not only named and returned my collection in short order, retaining only one specimen for further study, but even added a male and female each, of three species which we did not have. Such generosity on the part of a systematist is indeed exceptional and merits special mention and thanks which are herewith gratefully extended.

Most writers on the Hymenoptera and authors of text books place these wasps in the Family Cerceridae of the superfamily Sphecoidea: the Synoptic Catalogue of the Hymenoptera of America North of Mexico by Muesbeck, Krombein, Townes *et al*, places them in the Superfamily Sphecoidea, Family Sphecidae, Sub-Family Philanthinae, Tribe Cercerini. I have used the older nomenclature.

These small black and yellow, hard-bodies wasps are apparently not well represented in this Province. Whenever I encountered them in the course of some 28 years general collecting, I always captured them, but the collection contains only 83 specimens of four species, all but five of my own collecting. Their habits are difficult to study and have not been well worked out, but as far as known, they provision their nests with small to medium-sized weevils.

In the records following, I have taken their continental distribution and records of prey from the Synoptic Catalogue of Hymenoptera.

*Cerceris californica* Cresson. Recorded from "Southwestern States". We have three males from Kamloops taken during June and July. No prey records given.

*Cerceris nigrescens* Smith. Recorded from the northern States and southern Canada, from the Pacific to the Atlantic. We have 25 specimens of *C. nigrescens* taken from the dry belt, from Kelowna to the Chilcotin and from Royal Oak near Victoria; they were captured from May to August. Prey is recorded as (a) *Hyperodes delumbis* (Gyll) of which we have no specimens; but a close relative *H. interstitialis* (Dietz) occurs in the Nicola Valley; (b) *Sitona hispidula* (Fab.) which is common all over the dry belt; (c) *Gymnaetron* sp., of which genus we have *G. tetrum,* the mullein weevil, from Kamloops and Chilliwack; (d) *G. antirrhini* Payk. which occurs in Vancouver.

*Cerceris sextoides* Banks. Listed as occurring from Washington to California. No prey is recorded for this species. We have 41 specimens, all from Kamloops, collected during the summer months.

*Eucerceris flavocincta* Cresson. Recorded from the Rocky Mountains and the West at 2000 ft. and above. We have 14 specimens taken from May to July, from Oliver to the Chilcotin and two males from near Nanaimo on tidewater. This apparently, is a new and unusual altitudinal record. The prey is listed as *Dyslobius lecontei* Casey, of which we have only two specimens, both from Victoria; but *D. verrucifer* Casey occurs all over the dry belt and *D. granicollis* (Lec.) at Langley, Victoria and Cowichan.

The gift species from Professor Scullen are a male and female each of *Eucerceris montana* Cresson, *E. canaliculata* (Say) and *E. tricolor* Cockerell, of which none has apparently been recorded from Canada.

Doubtless several more species will be recorded for this Province, but at present I record only four native ones and three from outside British Columbia.

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## THE LIFE HISTORY OF *EUTHYATIRA SEMICIRCULARIS* GRT. (LEPIDOPTERA: THYATIRIDAE)

George A. Hardy
Provincial Museum, Victoria, B.C.

The handsome moth *Euthyatira semicircularis* Grt. turns up occasionally at light in May and June, but is by no means common on southern Vancouver Island, as far as my experience goes.

It has a wing expanse of 40 to 45 mm. Its colour is a blend of various shades of grey and brown, with a series of dark semicircular lines crossing the fore-wings, concave towards the wing bases, a characteristic which has evidently prompted the specific name. A white basal patch and a light grey area on the wing tips contrasts with the prevailing soft greys and browns. When at rest, with the wings closely applied to the body, the moth resembles a piece of dead, broken-off twig so closely as to make detection difficult even for the practised eye.

In British Columbia this moth appears to be confined to southern

Vancouver Island and parts of the adjacent mainland, north to Lillooet and west to Fraser Mills.

**Ovum.** Thirteen white ova were found on a leaf of *Alnus oregona* at Deep Cove, Saanich, Vancouver Island, on July 3, 1954. They were spaced irregularly in a group. Length 1 by .5 mm., elongate, slightly flattened, coarsely ribbed and cross-ribbed. Hatched on July 6. Larvae did not eat egg-shells.

**Larva. 1st Instar.** Length 2 mm. Colour snow-white throughout. Rests with anterior and posterior ends of body raised, head drawn in. Feeds on *Cornus occidentalis.* At 7 days the colour is white with suffused green showing through body wall owing to ingested food.

**2nd Instar.** July 16. Length 7 mm. Colour as before.

**3rd Instar.** Aug. 4. Length 12 mm. Head, pale brown with a black patch on each side of face on which the eyes are situated. Body, T. 1 with 4 black dots on each side of dorsum. Colour off white, broadly suffused with translucent green. Body slightly tapering towards posterior. Growth in early stages very slow. Hides in folded leaf by day, and comes out to feed by night. When disturbed it curls up sideways.

August 18. Length 20 mm.; no moult observed.

**4th Instar.** Aug. 31. Length 20 mm. Head pale pink. Eyes on a black background. Body, fuscous stippled on a white base, shading into a dull white on the underside; a dark ill-defined dorsal line. Legs and prolegs dull white, matching the underside.

**5th Instar.** Sept. 12. Length 40 mm. Head, flesh colour, cervical plate dark brown. Body, dull white with fuscous green showing through, heavily sprinkled with white dots. A suffused dark green dorsal line; spiracles orange ringed with black. Larva spun a light cocoon between a leaf and the side of glass container and pupated on Sept. 21.

**Pupa.** Size 15 by 5 mm. Dull black with a purple tinge, pleura light brown integument finely wrinkled and pitted, except the last two segments which are shiny. Cremaster a stout projection tipped with two thick and several thinner and shorter hooked spines.

**Imago.** Emerged June 8, 1955.

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## THE LIFE HISTORY OF *ZENOPHLEPS LIGNICOLORATA VICTORIA* TAYL. (LEPIDOPTERA: GEOMETRIDAE)

GEORGE A. HARDY

Provincial Museum, Victoria, B.C.

The dainty little geometer *Zenophleps lignicolorata victoria* Tayl. has been considered somewhat of a rarity in the Victoria district, but during the past three years the writer has found it frequently in its haunts, at the right season of the year, in Saanich and west to Goldstream, Vancouver Island. It is associated with open woods of mixed deciduous and coniferous trees. From lack of information on the early stages it was at first thought to feed on trees, especially Garry oak, as it was frequently found resting on the grass at the foot of this species. It lay with the wings partially closed, flat out, not held erect over the body, and quite conspicuously in the open. Only on dull days or early in the day was it thus to be found.

On other occasions this moth was found in similar situations in fir woods, resting on moss rather than grass.

*Z. l. victoria* measures 30 mm. across the expanded wings, the colour of which consists of soft shades of creams and light browns; a central darker band across the forewings contrasts with the lighter background colour. It flies in late August and early September, occasionally attracted to light, but is most often found or disturbed by day.

**Ovum.** An adult from Hudson Bay woods laid 60 ova on August 28, 1954. Another from Mt. Douglas, Saanich, land 15 ova on September 15 to 18, 1954. Egg .9 by .5 mm., elliptical, slightly flattened, broader and thicker at one end, minutely reticulated, white, gradually turning to pink or rusty colour in 15 to 20 days, and finally to lead colour. The following dates refer to the first group.

**Larva. 1st Instar.** March 17, 1955. Length 2 mm. Head shiny, light brown with a few short hairs. Body brownish olive-green, spiracular line pale beige shading into slightly darker beige beneath. The larva emerges through a neat round hole in the larger end of the egg. It does not eat the shell. It spins a thin silken thread as it moves about. Of the available plants, *Galium aparine* was the only one which it would eat.

**2nd Instar.** March 27. Length 5 mm. Head grey, dotted with black. Body pale grey to sage green, two white dorsal lines. Two black dots on A 1 to 4, three arranged in a triangular form with apex anteriorly on A 4 and 5, and a black longitudinal dorsal mark on A 7 and 8. Underside beige with three to five dark lines running the length of the body. Spiracles black. An interrupted fuscous line just above the spiracles.

**3rd Instar.** April 3. Length 10 mm. Head almost transparent bluish-white, finely spotted with black on sides and top of front. Body ochre-green to beige or dead grass colour, or in some, a yellowish-green. The two white dorsals are less noticeable than in the 2nd instar; a black median mark replaces the two spots of the earlier phase. In some cases the triangularly arranged spots on A 4 and 5 merge into a larger or smaller dark patch, varying in individual larvae. Underside with three longitudinal fuscous lines. Anterior edge of prolegs edged with a fuscous line, shorter on the anal pair.

**4th Intar.** April 8. Length 15 to 20 mm. Colour and markings as before, though the nearly equal width of the light ground colour, and the darker lines, gives a more striped appearance. Underside has at least five of these longitudinal stripes. Each segment has small, white, setae-bearing tubercles, fuscous-ringed at base.

When fully fed the larvae averaged 28 mm. long. They feed at night, hiding among the lower leaves, or resting on the stem or leaf margin by day.

On April 16, some of the larvae started to burrow beneath the sand at the bottom of the jar and made fragile cocoons by fastening sand grains together with silk. On April 19 several had pupated.

**Pupa.** Length 10 by 3 mm., uniformly fuscous brown. Cremaster of two slender closely approximated spines, slightly divergent and minutely recurved at tip.

**Imago.** Adults emerged in 1955 as follows:—

May 1. Apparently one larvae escaped and pupated in the room; the higher temperature accelerated its development.

June 12 - August 15, 1955. Emergence in ones and twos, chiefly from July 24 to August 15.

# ADVANCE OF THE SATIN MOTH, *STILPNOTIA SALICIS* (L.), INTO THE INTERIOR OF BRITISH COLUMBIA[1]

S. F. CONDRASHOFF

Forest Biology Laboratory, Vernon, B.C.

The most easterly record for the satin moth, *Stilpnotia salicis* (L.), in British Columbia was marked in the summer of 1955, when larvae were found on poplar trees at Kinsmen Beach in Vernon. First reports of this pest of poplars came from New Westminster in 1920, and in 1921 from Vancouver, where it is believed to have first entered the Province from Europe in 1918. Subsequently it has spread steadily northeastward into the Interior as far as Vernon.

1 Contribution No. 326, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
* "Records of occurrence" refers to feeding larvae.

In its advance, apparently two main routes were taken from the original point of entry at Vancouver (Fig. 1). One route followed the Canadian Pacific and Canadian National Railways through Kamloops, with the following records of occurrence*: New Westminster 1920; Mission 1926; Chilliwack 1926; Keefers 1933; south of Lytton 1933; Lytton 1945; Spences Bridge 1946 (?); Ashcroft 1949; Savona 1949; Kamloops 1950; Bestwick 1951; North Arm Okanagan Lake 1954 ;and Vernon 1955. The other route followed the Pacific Great Eastern Railway with the following

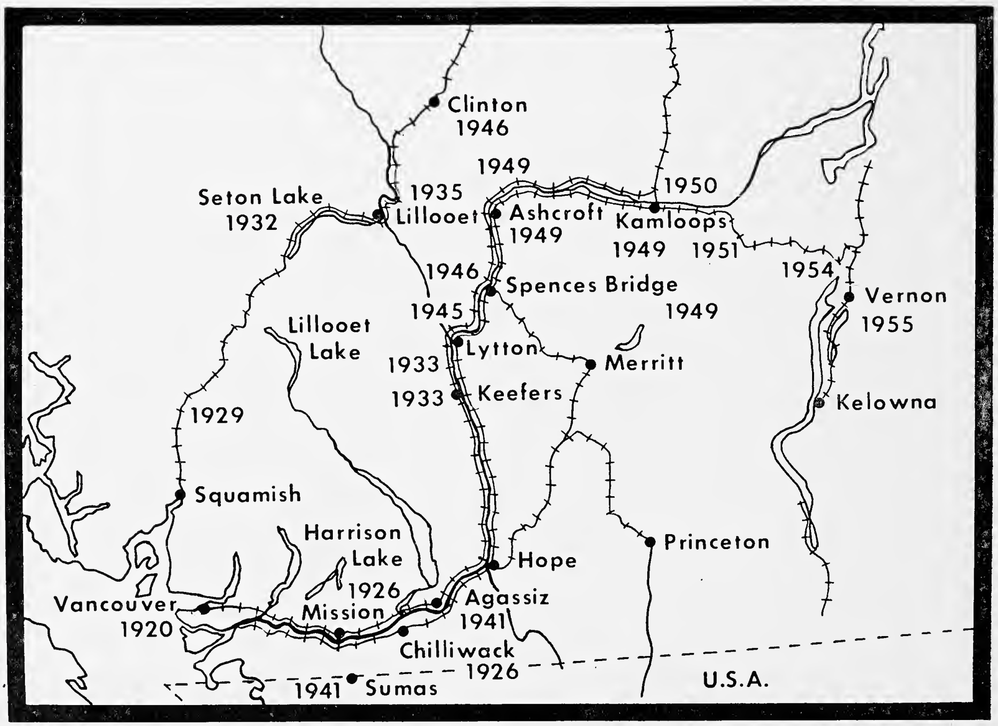


Fig. 1.—Advance of the satin moth, *Stilpnotia salicis* (L.), into the interior of British Columbia, 1920-1955

records: Squamish Valley 1929; Seton Lake 1932; Lillooet 1935; and Clinton 1946.

Theories have been advanced to account for the mode of the satin moth's distribution, a popular one being that the insect was probably carried into the interior of the Province by means of trains. As early as 1935 adult satin moths were found in freight cars at Kamloops, and at other times egg masses have been found on box cars. Records of infestations through the years have, in general, come from localities along the major railways previously mentioned. Records of insect occurrence, however, often depend upon the accessibility of the areas in which the insects are likely to occur, so that possibly records along the railways might have been reported more frequently because of ease of detection. Other means of transport must not be overlooked as automobiles entering the Okanagan have been known to carry adults of the satin moth. The adults are not very discriminating as to where they deposit their eggs, which have been found on houses, glass, and on many other sites and objects. Eggs deposited on a movable object might be transported in unusual ways, but nevertheless effectively.

In some cases infestations have occurred miles from any roads or railways and might be attributed to moth flight or aerial dispersal of the larvae. It has been noted that the adult moths can fly over considerable distances under favourable conditions.

The spread of the satin moth in British Columbia was not a gradual and continuous movement, but occurred in spurts and jumps in a very irregular fashion as regards time between "moves" and distance covered during each move. The spasmodic movement eastward is also reflected by the limited number of parasite species and the number of individuals obtained in parasite studies in the interior of British Columbia during recent years.

The advance of the satin moth has also been governed by the availability of host tree species. Glendenning (1932) observed that the insect at first registered some incompatibility towards black cottonwood. Later records show that it will feed on all poplars in British Columbia including at least the commoner introduced species, although in mixed stands it seems to attack some species in preference to others. In the Interior, trembling aspen is apparently the favoured host.

The satin moth in its advance into the interior of British Columbia has exhibited ability to adapt itself to new conditions of climate and to new hosts. Likewise, in addition to its own means of locomotion, it has made use of artificial means of transport, such as ships in entering the continent, with trains and automobiles aiding its dispersal within the Province. This insect is now a well established and successful pest in the interior of British Columbia and is capable of further spread in the future.

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**A note on** *Tribolium destructor* Utten. (Coleoptera: Tenebrionidae)

In September 1954, an agent from an importing firm brought me a small quantity of tea leaves which had been returned to the firm with the complaint that it was infested by insects. The agent gave me two black beetles 1/6 inch long, two beetle pupae and three larvae in a few spoonfulls of tea. I used the tea leaves for a brew and cultured out the insects in pulverized Purina fox-chow pellets. This medium apparently suits these insects, which have since developed in thousands.

Mr. Peter Zuk of the Stored Product Insect Laboratory, Vancouver, identified the beetles as *Tribolium destructor* Utten. In our collections was one of two specimens I had taken in Vancouver in 1951 that were identified in 1954 by Dr. D. W. Boddy of Seattle as *Aphanotus brevicornis* Lec. A series sent to Mr. Gordon Stace-Smith was pronounced to be *A. brevicornis*. This is apparently a relatively rare beetle because Mr. Stace-Smith, Mr. H. B. Leech of the California Academy of Sciences and the Systematic Unit at Ottawa, were all glad to have a series. Mr. W. Brown of the Systematic Unit requested a living colony because the National Collection had no specimens of this species. After studying it, Mr. Brown reported that the insect is not *Aphanotus brevicornis* Lec., but is *Tribolium destructor* Utten. even as Mr. Zuk had identified it at first.

The original stock that the agent received and later gave me, probably developed in cereals, from which the larvae migrated to nearby tea leaves for pupation; they certainly do not feed on tea leaves.

—*G. J. Spencer, University of British Columbia.*

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# CHEMICAL CONTROL OF ROOT MAGGOTS IN EARLY CABBAGE[1]

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Eight large-scale experiments on chemical control of root maggots in early cabbage were conducted from the Victoria laboratory during the years 1947-1953 and 1955. The phase of the investigation relating to methods of evaluating damage and control has already been reported (King, Forbes, and Noble, in preparation).

Before 1920, controls recommended in North America were limited to cultural or mechanical methods (Goff, 1892; Slingerland, 1894; Schoene, 1916; Gibson and Treherne, 1916). Use of a tarred felt paper pad around the stem of each transplant, though effective, was very laborious and not commercially practical. Chemical control, in the usual sense, did not exist until Brittain (1920) published experimental evidence of the effectiveness and practical value of corrosive sublimate, previously reported (*e.g.*, Slingerland, 1894) to have been employed for many years by some commercial growers in Great Britain as a trade secret. Brittain's results were soon confirmed by other workers, and the effectiveness of calomel was demonstrated by Glasgow (1929) and others. Both of these chemicals were expensive and the labor cost was also high since repeated applications were necessary. Although these two chemicals continued for many years to be valuable standard remedies against root maggots, thorough re-investigation of the problem became imperative when, with the advent of the chlorinated hydrocarbons, there was promise of developing more economical controls (Carlson *et al.*, 1947). The materials first tried gave disappointing results (Dills *et al.*, 1944), but others later proved more effective (Eide & Stitt, 1950; Semenov 1950; and others). It was at the early stage of this development that the present study was begun.

The methods used to evaluate control measures have not always been discussed, especially in the earlier literature. Important exceptions include Brittain (1920), Wright (1953), and King *et al.* (in preparation). The latter concluded: (1) that yield on an area basis provides the best summation of the effects of attack and of chemical treatment, environmental factors being considered; (2) that yields from different experiments are best compared when each is expressed as a percentage of the yield of the highest-yielding treatment of its own

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experiment; and (3) that the number of plants ruined by maggots provides the best single measure of protection.

The cabbage maggot, *Hylemya brassicae* (Bouché), was the pest species involved in all the experiments. Infestation by first-generation larvae is the critical factor in the production of early cabbage in coastal British Columbia. Flies begin to emerge from overwintered puparia during the first long warm period in April or May and lay eggs about a week later (Table I).

**TABLE I.—Seasonal data on egg-laying, transplanting, and harvesting for the experimental area, Victoria, B.C., 1947 - 1956.**

| Year | Beginning of egg-laying | Peak of 1st-generation eggs | Peak of 2nd-generation eggs | Trans-planting | Harvest |
|---|---|---|---|---|---|
| 1947 | April 23 | — | — | April 11 | June 17 - July 10 |
| 1948 | April 26 | — | — | April 16 | July 20 - Aug. 3 |
| 1949 | April 25 | — | — | April 26 | July 12 - Aug. 15 |
| 1950 | May 8 | — | — | May 25 | Aug. 7 - Sept. 12 |
| 1951 | May 3 | — | — | June 5 | Aug. 8 - Sept. 4 |
| 1952 | April 24 | May 26 | July 7 | April 17 | July 21 - Aug. 13 |
| 1953 | April 24 | June 1 | July 6 | April 21 | July 21 - Aug. 19 |
| 1954 | — | May 31 | July 9 | — | — |
| 1955 | May 2 | May 23 | June 30 | May 3 | Aug. 2 - Aug. 12 |
| 1956 | May 2 | May 17 | July 1 | — | — |

At Victoria early cabbages are transplanted to the field during April or May. Consequently the peak of spring egg-laying (Table I) occurs when the plants are still small and not fully established. They may also receive considerable numbers of second-generation eggs, but this infestation does not greatly affect production since the plants are then nearly mature.

## Methods and Materials

All the experiments were conducted at Victoria, on a farm with clay-loam soil. A randomized block design was used each year except in 1950 and 1951, when a latin square design was used. There were four replications in 1947 and 1948, six in 1949 and 1955, seven in 1953, eight in 1952, and ten in 1950 and 1951. There were generally 40 to 60 plants per plot.

Plants were started in the greenhouse or in seed-beds protected from infestation. Transplanting dates are shown in Table I.

All plants were inspected frequently throughout the growing season to note dying plants and determine cause of death, and to record other pertinent data such as indications of phytotoxicity. Individual plant records were maintained. Harvest data were taken as groups of plants matured. Analysis of variance was used in evaluating the results.

Plants that died or failed to produce marketable heads from causes outside the scope of the experiment were not included in the final results. These included plants ruined by cultivation injury, flooding, wire stem, club root, muskrats, and cutworms. The number of plants involved was usually very small. The same procedure was followed in 1950, the one year when because of failure of protective measures in the seed-beds, some of the transplants were infested by root maggots when they were set out. As these plants succumbed much more quickly than those infested after transplanting, they were eliminated from consideration without affecting the appraisal of treatments.

**TABLE II.—Percentages of early cabbage ruined and yields after various treatments against the cabbage maggot at Victoria, B.C., 1948-1955.**

| Treatment | | | Rate[1] | Number of Applications | Plants Ruined by Maggots, % | | | | | | Yield[2] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1948 | 1949 | 1950 | 1952 | 1953 | 1955 | 1948 | 1949 | 1950 | 1952 | 1953 | 1955 |
| Check | | | — | — | 41 | 48 | 23 | 34 | 23 | 90 | 42 | 44 | 62 | 55 | 51 | 6 |
| Corrosive sublimate | | 1:1600 | 3 oz./plant | 3 | 9 | | | | | | 66 | | | | | |
| Calomel-talc | dust | 4% | 40 lb./acre | 3 | 8 | | | | | | 64 | | | | | |
| | stem | 50% | 1 oz./250 plants | 1 | 15 | | | | | | 64 | | | | | |
| Parathion | dust | 2% | 40 lb./acre | 2 | 6 | | | | | | 88 | | | | | |
| Toxaphene | dust | 10% | 40 lb./acre | 3 | 42 | | | | | | 39 | | | | | |
| DDT | dip | 50% | 0.5 oz.[1] | 1 | | | 3 | 2 | | | | | 91 | 92 | | |
| | stem | 50% | 1 oz./250 plants | 1 | 1 | 25 | 1 | | | | 84 | 59 | 100 | | | |
| | spray | 50% | 3 lb. | 2 | | 34 | | | | | | 58 | | | | |
| BHC | dust | 0.5%g | 40 lb./acre | 3 | 3 | 11 | 4 | | | | 95 | 96 | 93 | | | |
| | | | | 2 | | 12 | 2 | | | | | 95 | 94 | | | |
| | | | | 1 | | 16 | 2 | 7 | | | | 78 | 90 | 80 | | |
| | spray | 50% | ¼ lb.g | 3 | 2 | | 3 | | | | 100 | | 94 | | | |
| | | | | 2 | | 11 | | | | | | 88 | | | | |
| | | | | 1 | | 20 | | | | | | 82 | | | | |
| Dieldrin | dust | 1% | 40 lb./acre | 2 | | | 2 | | | | | | 87 | | | |
| | | | | 1 | | | 3 | | | | | | 88 | | | |
| | spray | emulsion[3] | 1 lb. | 1 | | | 2 | | | | | | 95 | | | |
| Chlordane | dust | 5% | 40 lb./acre | 3 | 19 | | | | | | 55 | | | | | |
| | | 10% | 40 lb./acre | 2 | | | 8 | | | | | | 86 | | | |
| | | 10% | 40 lb./acre | 1 | | | 6 | | | | | | 81 | | | |
| | | 5% | 40 lb./acre | 1 | | | | 12 | 4 | 46 | | | | 73 | 71 | 44 |
| | spray | emulsion[4] | 2 lb. | 2 | | 10 | | | | | | 100 | | | | |
| | | emulsion[5] | 2 lb. | 1 | | | 1 | | | | | | 93 | | | |
| Aldrin | dust | 1% | 40 lb./acre | 3 | | | 3 | | | | | | 92 | | | |
| | | | | 2 | | | 3 | | | | | | 90 | | | |
| | | | | 1 | | | 5 | | | | | | 89 | | | |
| | | 2.5% | 40 lb./acre | 1 | | | | 1 | 3 | 7 | | | | 78 | 100 | 100 |
| | dip | emulsion[3] | 0.2 oz. | 1 | | | | 1 | 0 | 0 | | | | 83 | 89 | 90 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | spray emulsion[4] | | 1 lb. | 2 | | | 1 | | | | | | 96 | | | |
| | | | | 1 | | | 2 | | | | | | 91 | | | |
| | spray emulsion[3] | | 2.5 lb. | 1 | | | | 0 | 0 | | | | | 100 | 89 | |
| Heptachlor | dust | 10% | 40 lb./acre | 2 | | | 1 | | | | | | 90 | | | |
| | | | | 1 | | | 3 | | | | | | 84 | | | |
| | | 2.5% | 40 lb./acre | 1 | | | | 1 | 1 | 9 | | | | 94 | 91 | 87 |
| | dip emulsion[3] | | 0.2 oz. | 1 | | | | | 0 | 0 | | | | | 79 | 94 |
| | spray emulsion[4] | | 1 lb. | 1 | | | 2 | | | | | | 93 | | | |
| Difference necessary for significance: | | | at 5% level | | 15 | 11 | 1 | 9 | 6 | 16 | | | | | | |
| | | | at 1% level | | 20 | 14 | 2 | 12 | 8 | 23 | | | | | | |

1 For dips: ounces of toxicant per gallon of dip. For sprays: pounds of toxicant per 100 gallons of spray, applied at 3 ounces per plant.

2 Percentage of yield for highest-yielding treatment of the year: 1948, 26.4 tons per acre; 1949, 13.6; 1950, 10.8; 1952, 10.9; 1953, 15.1; and 1955, 18.6.

3 Two pounds of toxicant per gallon.

4 Four pounds of toxicant per gallon.

5 Eight pounds of toxicant per gallon.

During the experiments, 10 insecticides were used in 41 treatments. The insecticides were: aldrin, BHC, calomel, chlordane, corrosive sublimate, DDT, dieldrin, heptachlor, parathion, and toxaphene. These were used in standard formulations of the period except as specifically noted.

Five methods of application were used: Dip and stem treatments were applied to the transplants just before they were replanted in the field. Drenches, dusts, and sprays were applied around the bases of the plants soon after they were set out, usually within two days.

In the dip treatments, the mixture was a wettable powder (DDT) or an emulsifiable concentrate (aldrin, heptachlor, chlordane) in water. The entire plant was immersed in the DDT mixture since this procedure protected the young plants from flea beetles. Only the roots and stems of the plants were dipped in the emulsions, however, because of the danger of phytotoxic effects from dipping the entire plant. No further treatment was given.

In the stem treatments, the transplants were moistened and the stems (not roots) dusted with approximately 1 ounce of dust per 250 plants. No further treatment was given.

The drench treatment was used only for applying corrosive sublimate solution, in 1947 and 1948. One-third to one-half of a cupful, approximately 3 ounces, of a 1:1600 solution was poured on the soil at the collar of each plant. There were three applications, at ten-day intervals, starting shortly after transplanting or at the beginning of egg-laying.

In the dust treatments, dust was applied with a puffer duster, one or two puffs on the soil around the collar of each plant, at approximately 40 pounds per acre. There were 1 to 3 applications, starting shortly after transplanting. Second and third applications were made at ten-day intervals.

**TABLE II.—Percentages of early cabbage ruined and yields after various treatments against the cabbage maggot at Victoria, B.C., 1948-1955.**

| Treatment | | | Rate[1] | Number of Applications | Plants Ruined by Maggots, % 1948 | 1949 | 1950 | 1952 | 1953 | 1955 | Yield[2] 1948 | 1949 | 1950 | 1952 | 1953 | 1955 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Check | | | — | — | 41 | 48 | 23 | 34 | 23 | 90 | 42 | 44 | 62 | 55 | 51 | 6 |
| Corrosive sublimate | | 1:1600 | 3 oz./plant | 3 | 9 | | | | | | 66 | | | | | |
| Calomel-talc | dust | 4% | 40 lb./acre | 3 | 8 | | | | | | 64 | | | | | |
| | stem | 50% | 1 oz./250 plants | 1 | 15 | | | | | | 64 | | | | | |
| Parathion | dust | 2% | 40 lb./acre | 2 | 6 | | | | | | 88 | | | | | |
| Toxaphene | dust | 10% | 40 lb./acre | 3 | 42 | | | | | | 39 | | | | | |
| DDT | dip | 50% | 0.5 oz.[1] | 1 | | | 3 | 2 | | | | | 91 | 92 | | |
| | stem | 50% | 1 oz./250 plants | 1 | 1 | 25 | 1 | | | | 84 | 59 | 100 | | | |
| | spray | 50% | 3 lb. | 2 | | 34 | | | | | | 58 | | | | |
| BHC | dust | 0.5%g | 40 lb./acre | 3 | 3 | 11 | 4 | | | | 95 | 96 | 93 | | | |
| | | | | 2 | | 12 | 2 | | | | | 95 | 94 | | | |
| | | | | 1 | | 16 | 2 | 7 | | | | 78 | 90 | 80 | | |
| | spray | 50% | ¼ lb.g | 3 | 2 | | 3 | | | | 100 | | 94 | | | |
| | | | | 2 | | 11 | | | | | | 88 | | | | |
| | | | | 1 | | 20 | | | | | | 82 | | | | |
| Dieldrin | dust | 1% | 40 lb./acre | 2 | | | 2 | | | | | | 87 | | | |
| | | | | 1 | | | 3 | | | | | | 88 | | | |
| | spray | emulsion[3] | 1 lb. | 1 | | | 2 | | | | | | 95 | | | |
| Chlordane | dust | 5% | 40 lb./acre | 3 | 19 | | | | | | 55 | | | | | |
| | | 10% | 40 lb./acre | 2 | | | 8 | | | | | | 86 | | | |
| | | 10% | 40 lb./acre | 1 | | | 6 | | | | | | 81 | | | |
| | | 5% | 40 lb./acre | 1 | | | | 12 | 4 | 46 | | | | 73 | 71 | 44 |
| | spray | emulsion[4] | 2 lb. | 2 | | 10 | | | | | | 100 | | | | |
| | | emulsion[5] | 2 lb. | 1 | | | 1 | | | | | | 93 | | | |
| Aldrin | dust | 1% | 40 lb./acre | 3 | | | 3 | | | | | | 92 | | | |
| | | | | 2 | | | 3 | | | | | | 90 | | | |
| | | | | 1 | | | 5 | | | | | | 89 | | | |
| | | 2.5% | 40 lb./acre | 1 | | | | 1 | 3 | 7 | | | | 78 | 100 | 100 |
| | dip | emulsion[3] | 0.2 oz. | 1 | | | | 1 | 0 | 0 | | | | 83 | 89 | 90 |
| | spray | emulsion[4] | 1 lb. | 2 | | | 1 | | | | | | 96 | | | |
| | | | | 1 | | | 2 | | | | | | 91 | | | |
| | spray | emulsion[3] | 2.5 lb. | 1 | | | | 0 | 0 | | | | | 100 | 89 | |
| Heptachlor | dust | 10% | 40 lb./acre | 2 | | | 1 | | | | | | 90 | | | |
| | | | | 1 | | | 3 | | | | | | 84 | | | |
| | | 2.5% | 40 lb./acre | 1 | | | | 1 | 1 | 9 | | | | 94 | 91 | 87 |
| | dip | emulsion[3] | 0.2 oz. | 1 | | | | | 0 | 0 | | | | | 79 | 94 |
| | spray | emulsion[4] | 1 lb. | 1 | | | 2 | | | | | | 93 | | | |
| Difference necessary for significance: | | | at 5% level | | 15 | 11 | 1 | 9 | 6 | 16 | | | | | | |
| | | | at 1% level | | 20 | 14 | 2 | 12 | 8 | 23 | | | | | | |

1 For dips: ounces of toxicant per gallon of dip. For sprays: pounds of toxicant per 100 gallons of spray, applied at 3 ounces per plant.
2 Percentage of yield for highest-yielding treatment of the year: 1948, 26.4 tons per acre; 1949, 13.6; 1950, 10.8; 1952, 10.9; 1953, 15.1; and 1955, 18.6.
3 Two pounds of toxicant per gallon.
4 Four pounds of toxicant per gallon.
5 Eight pounds of toxicant per gallon.





During the experiments, 10 insecticides were used in 41 treatments. The insecticides were: aldrin, BHC, calomel, chlordane, corrosive sublimate, DDT, dieldrin, heptachlor, parathion, and toxaphene. These were used in standard formulations of the period except as specifically noted.

Five methods of application were used: Dip and stem treatments were applied to the transplants just before they were replanted in the field. Drenches, dusts, and sprays were applied around the bases of the plants soon after they were set out, usually within two days.

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The drench treatment was used only for applying corrosive sublimate solution, in 1947 and 1948. One-third to one-half of a cupful, approximately 3 ounces, of a 1:1600 solution was poured on the soil at the collar of each plant. There were three applications, at ten-day intervals, starting shortly after transplanting or at the beginning of egg-laying.

In the dust treatments, dust was applied with a puffer duster, one or two puffs on the soil around the collar of each plant, at approximately 40 pounds per acre. There were 1 to 3 applications, starting shortly after transplanting. Second and third applications were made at ten-day intervals.

In the spray treatments, a spray was applied to the soil around the collar of each plant with a bucket pump sprayer for a timed period, usually 5 seconds, predetermined to wet thoroughly the soil surrounding the plant. Approximately 3 ounces of spray were applied to each plant. There were 1 to 3 applications.

The treatments were evaluated on the basis of yields and plants ruined by maggots (King *et al.*, in preparation). The plants ruined comprised those killed by root maggot attack and those that because of root maggot attack failed to produce marketable heads weighing at least 12 ounces by the last harvest. For analysis, the number was expressed as a percentage. For determination of yields, marketable heads cut at each harvest from each plot were weighed, and the total weight and number of heads were recorded. The average weight per marketable head was calculated from these data. Yields per acre were calculated on the basis of 10,000 plants per acre and the percentage of plants ruined by maggot attack.

The varieties of cabbage used were: Green Acre, 1948 and 1949; Golden Acre, 1947 and 1950 - 1953; Cluseed, 1955. There was a single replicate of the variety Flowers of the Garden in the 1947 experiment.

## Results and Discussion

Results of six years' experiments are given in Table II. In 1950, 1952, and 1953 the infestations were moderate, whereas in 1948 and 1949 they were heavy. The infestation in 1955, when 90 per cent of the untreated plants were killed by root maggots, was by far the heaviest encountered in the studies and provided a very severe test.

In the other two experiments, 1947 and 1951, root maggot infestations were too light to provide a critical test, less than 2 per cent of the untreated plants being killed in either case. In 1951 this was largely the result of late transplanting, so that the plants escaped first-generation infestation.

With stem brassicas, the critical period for damage by root maggots is the two or three weeks between transplanting and establishment (King *et al.*, in preparation). Infestation after the plants are established is less serious. To give satisfactory control, a treatment must provide almost complete protection at this time, but need not prevent all infestation later in the season. The critical period is long enough, however, to necessitate two or more applications of any treatments that have little residual effect.

The most effective and economical of all the materials were aldrin and heptachlor, as previously shown also for rutabagas (King & Forbes, 1954; King *et al.*, 1955; Forbes & King, 1956). One application of either aldrin or heptachlor dust gave almost complete control in every instance. These materials in spray form gave comparable results and also killed wireworms. Dip treatments gave the greatest reduction in maggot damage obtained, almost all the roots being free from feeding. However, they were sometimes phytotoxic. In the 1955 experiment each killed eight per cent of the plants, within two weeks after transplanting. A different commercial formulation applied at the same rate in 1955 by a co-operating grower showed no phytotoxicity to early cabbage, while providing almost complete control. Gould (1955) suggests several precautions that reduce or prevent phytotoxicity.

Dieldrin dust and spray were about equal to aldrin and heptachlor in effectiveness in the one year of trial.

In some of the early experiments, chlordane appeared to be rather promising. Fair control was obtained with a spray treatment in 1949 and 1950 and with a dust treatment in 1950. Later experiments, however, showed chlordane dust to be unreliable, particularly in heavy infestations.

Multiple applications of BHC dust or spray in the earlier experiments gave outstanding control. Single applications, tested in 1949 and 1950, gave somewhat poorer though still adequate commercial control.

The DDT stem treatment gave good control in 1948 and 1950. The DDT dip treatment used in 1950, 1951, and 1952, which was developed as a more rapid and convenient method of applying the DDT to the roots and stems, was also effective.

Two applications of parathion dust gave good control in 1948. Parathion was not tested further in view of the availability of other effective materials having much lower mammalian toxicity.

Corrosive sublimate drench and calomel-talc dust, each with three applications, were the standard treatments for maggot control in early cabbage in 1947. They were, therefore, included in the 1947 and 1948 experiments. The 1947 test was inadequate. In the 1948 experiment they gave reasonably good control but were surpassed by several other treatments, especially on the basis of yield and economy. For example, in 1948, yields with these treatments were only about two-thirds those with other treatments that afforded comparable reduction in maggot damage. The relatively low yields with these mercury compounds were probably attributable to their strongly phytotoxic properties. The calomel stem treatment showed a similarly reduced yield.

Toxaphene dust, chlordane dust, DDT spray, and calomel stem treatment were unsatisfactory as tested in these experiments.

## Conclusions

To provide the best test of treatments against root maggots, stem brassicas should be exposed to the heaviest infestation possible. At Victoria this is usually achieved when the crop is transplanted to the field as early in the spring as growth conditions are suitable. The crop is then at the critical stage of growth, *i.e.,* between transplanting and establishment, when egg-laying by the adult of the cabbage maggot is at its peak. To achieve protection, it is essential to prevent attack for a least ten days after transplanting, and to minimize it for a further three or four weeks.

The eight years' field experiments demonstrated that corrosive sublimate drench and calomel-talc dust treatments, which were the standard treatments for maggot control on cabbage in Canada up to 1949, were inferior to treatments with the chlorinated hydrocarbons, especially on the bases of yield and cost. Aldrin and heptachlor were the most effective chemicals, a single application providing almost complete protection against very heavy infestations.

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# DIPTERA TAKEN AT ROBSON, B.C.

H. R. FOXLEE

Robson, B.C.

Robson is in the southern part of the West Kootenay region of British Columbia, close to the northeastern corner of the State of Washington. The elevation is about 1410 feet.

The Diptera in this list were taken between 1939 and 1955.

## ORTHORRHAPHA

NEMATOCERA

**Anisopodidae**

*Anisopus alternatus* Say.

**Simuliidae**

*Prosimulium fulvum* (Coq.)
*Simulium arcticum* Mall.
*Simulium hunteri* Mall.
*Simulium tuberosum* Lund.
*Simulium vittatum* Zett.

**Fungivoridae (Mycetophilidae)**

Ceroplatinae
*Apemon negriventris* Joh.
*Ceroplatus terminalis* Coq.

Sciophilinae
*Dziedzickia fuscipennis* (Coq.)
*Monoclona elegantula* Joh.

Fungivorinae
*Rhymosia cristata* (Staeg.)

**Bibionidae**

*Bibio longipes* Lw.
*Bibio nervosus* Lw.
*Bibio slossonae* Ckll.

BRACHYCERA

**Stratiomyidae**

Clitellariinae
*Adoxomyia rustica* (O.S.)

Stratiomyinae
*Eulalia pubescens* (Day)
*Stratiomys barbata* Lw.
*Stratiomys maculosa* Lw.

Geosarginae
*Geosargus cuprarius* (L.)
*Geosargus decorus* (Say)
*Geosargus viridis* (Say)
*Microchrysa polita* (L.)

Beridinae
*Scoliopelta luteipes* Will.

**Rhagionidae**

Rhagioninae
*Rhagio concava* Leon.

Chrysopilinae
*Symphoromyia atripes* Big.

**Coenomyiidae**

*Arthroceras* sp.
*Xylophagus decorus* Will.

**Tabanidae**

Silviinae (Pangoniinae)
*Apatolestes comastes* Will.
*Chrysops asbestos* Philip
*Chrysops excitans* Wlk.
*Chrysops pertinax* Will.
*Silvius gigantulus* (Lw.)
*Stonemyia californica* (Big.)

Tabaninae
*Atylotus incisuralis* Macq.
*Tabanus aegrotus* O.S.
*Tabanus californicus* Mart.
*Tabanus captonis* Mart.
*Tabanus haemaphorus* Mart.
*Tabanus kesseli* Phil.
*Tabanus laniferus* McD.
*Tabanus lasiophalmus* Macq.
*Tabanus melanorhinus* Big.
*Tabanus nivosus* O.S.
*Tabanus nudus* McD.
*Tabanus procyon* O.S.
*Tabanus rhombicus* O.S.
*Tabanus rupestris* McD.
*Tabanus sequax* Will.
*Tabanus typhus* Whitn.
*Tabanus sonomensis* O.S.
*Tabanus zygotus* Phil.

**Cyrtidae**

*Eulonchus tristis* Lw.
*Ogcodes albiventris* Jhns.

**Bombyliidae**

Anthracinae
*Anthrax analis* Say
*Anthrax irrorata* Say
*Anthrax plesia* Cn.
*Anthrax pluto* Wd.
*Anthrax varia* F.
*Dipalta serpentina* O.S.
*Hemipenthes catulina* (Coq.)
*Hemipenthes morioides* (Say)
*Hemipenthes sinuosa* (Wd.)
*Villa agrippina* (O.S.)
*Villa alternata* (Say)
*Villa fulviana* (Say)
*Villa hypomelas* (McQ.)
*Villa lateralis* (Say)

Lomatiinae
*Aphoebantus* sp.

Toxophorinae
*Eclimus luctifer* (O.S.)
*Eclimus magnus* (O.S.)
*Eclimus muricatus* (O.S.)

Bombyliinae
*Bombylius albicapillus* Lw.
*Bombylius lancifer* O.S.
*Bombylius major* L.
*Bombylius validus* Lw.
*Systoechus oreas* O.S.

**Therevidae**

*Psilocephala canadensis* Cole
*Psilocephala munda* Lw.
*Psilocephala signatipennis* Cole
*Thereva brunnea* Cole
*Thereva cingulata* Krob.
*Thereva fucata* Lw.

**Omphralidae (Scenopinidae)**

*Omphrale fenestrale* (L.)
*Omphrale nubilipes* Say

**Asilidae**

Leptogastrinae
*Leptogaster* sp.

Dasypogoninae
*Chrysoceria pollenia* Cole
*Cyrotopogon banksi* W. and M.
*Cyrtopogon dasylloides* Will.
*Cyrtopogon leucozona* Lw.
*Cyrtopogon montanus* Lw.
*Cyrtopogon praepes* Will.
*Cyrtopogon sansoni* Cn
*Cyrtopogon willistoni* Cn
*Dioctria pusio* O.S.
*Dioctria sackeni* Will.
*Eucyrtopogon nebulo* (O.S.)
*Heteropogon senilis* (Big.)
*Lasiopogon aldrichi* Mel.
*Lasiopogon monticola* Mel.
*Metapogon setigerum* Cole ?
*Nicocles canadensis* Cn.
*Nicocles dives* (Lw.)
*Nicocles punctipennis* Mel.
*Stenopogon inquinatus* Lw.

Laphriinae
*Andrenosoma fulvicauda lutea* McAt. ?
*Bombomima astur* (O.S.)
*Bombomima asturina* Brom.
*Bombomima californica* (Bks)
*Bombomima columbica* (Wlk.)
*Bombomima fernaldi* (Back)
*Bombomima partitor* (Bks)
*Laphria aimatis* McAt.
*Laphria felis felis* O.S.
*Laphria felis crocea* McAt.
*Laphria ferox* Will.
*Laphria franciscana* Big.
*Laphria gilva* (L.)
*Laphria index* McAt.
*Laphria janus* McAt.
*Laphria sackeni* Will.
*Laphria sadales* Wlk.
*Laphria vivax* Will.
*Laphria vultur* O.S.
*Pogonosoma ridingsi* Cress.

Asilinae
*Asilus auriannulatus* (Hine)
*Asilus callidus* (Will.)
*Asilus occidentalis* Hine
*Asilus platyceras* Hine
*Asilus vescus* Hine
*Asilus willistoni* Hine

**Empididae**

Hybotinae
*Euhybos triplex* (Wlk.)

Ocydromiinae
*Leptopeza disparilis* Mel.
*Ocydromia glabricula* (Fln.)
*Oedalea* sp.
*Trichina astripes* Mil.
*Trichina pullata* Mel.

Empidinae
*Hesperempis mabelae* Mil. ?

Clinoceratinae
*Clinocera undulata* Mel.
*Dolichocephala irrorata* (Fln.)

Hemerodromiinae
*Hemerodromia rogatoris* Coq.
Tachydromiinae
*Platypalpus crassifemoris* Fitch
*Platypalpus flavirostris microcerus* Mel.
*Paltypalpus inops* Mel.
*Platypalpus juvenis hyaenoides* Mel.
*Platypalpus juvenis juvenis* Mel.
*Platypalpus pectinator* Mel.
*Platypalpus pilatus* Mel.
*Platypalpus trivialis* Lw.
*Platypalpus xanthopodus* Mel.
*Tachydromia bimaculata* (Lw.)
*Tachypeza discifera* Mel.

**Dolichopodidae**
Dolichopodinae
*Dolichopus consanguineus* Wheel.
*Dolichopus detersus* Lw.
Campsicneminae
*Chrysotimus pusio* Lw.
Chrysosomatinae
*Condylostylus pilicornis* (Ald.)

**Lonchopteridae**
*Lonchoptera dubia* Cn.

**Phoridae**
*Megaselia* sp.

## CYCLORRHAPHA

ASCHIZA

**Clythiidae (Platypezidae)**
*Callomyia venusta* Snow
*Clythia coraxa* Kess.
*Clythia polypori* (Willd.)
*Platypezina pacifica* Kess.

**Syrphidae**
Syrphinae
*Baccha obscuricornis* Lw.
*Didea fuscipes* Lw.
*Epistrophe diversipunctata* Cn.
*Epistrophe grossulariae* (Mg.)
*Eupeodes volucris* O.S.
*Melanostoma* sp.
*Metasyrphus amalopis* (O.S.)
*Metasyrphus lapponicus* (Zett.)
*Metasyrphus limatus* (Hine)
*Metasyrphus snowi* (Wehr)
*Metasyrphus venablesi* (Cn.) ?
*Paragus bicolor* (F.)
*Platycheirus peltatoides* Cn.
*Scaeva pyrastri* (L.)
*Syrphus opinator* O.S.
Chrysotoxinae
*Chrysotoxum integrum* Will.
*Chrysotoxum ventricosum* Lw.
Microdontinae
*Microdon cothurnatus* Big.
*Microdon piperi* Knab.
*Microdon tristis* Lw.
Eumerinae
*Eumerus strigatus* (Fln.)
*Eumerus tuberculatus* (Rond.)
Cheilosiinae
*Brachyopa* sp.
*Cartosyrphus tristis* (Lw.)
*Ferdinandea croesus* (O.S.)
*Neocnemodon auripleura* Cn.
*Neocnemodon calcarata* Cn.
*Pipiza oregona* Lov.
*Sphegina punctata* Cole
Volucellinae
*Volucella bombylans plumata* Deg.
*Volucella bombylans rufomaculata* Jones
Sericomyiinae
*Arctophila flagrans* O.S.
*Condidea lata* Coq.
*Pyritis kincaidii* (Coq.)
*Pyritis montigena* Hunt.
*Sericomyia chalcopyga* Lw.
Xylotinae
*Chrysosomidia crawfordi* (Shann.)
*Chrysosomidia pulcher* (Will.)
*Crioprora femorata* Will.
*Cynorhina armillata* O.S.
*Cynorhina nigripes* Cn.
*Cynorhina scitula* (Will.)
*Penthesilia aurata* Cn.
*Penthesilia aurea* (Lov.)
*Penthesilia caudata* (Cn.)
*Penthesilia coquilletti* (Will.)
*Penthesilia intermedia* (Jhns.)
*Penthesilia nigripes* (Will.)
*Sphecomyia pattoni* Will.
*Sphecomyia vespiformis* Gorski
*Xylota barbata* Lw.
*Xylota ejuncida* Say.
*Xylota flavitibia* Big.
*Xylota subfasciata* Lw.
*Xylotodes inarmatus* (Hunt.)
*Xylotodes pigra* (Lov.)
*Xylotomima curvaria* (Cn.)
*Xylotomima nemorum* (F.)
*Xylotomima pigra* (F.)
Tubiferinae
*Elophilus fasciatus* Wlk.
*Lampetia equestris narcissi* (F.)
*Tubifera anthophorina* (Fln.)
*Tubifera nemorum* (L.)
*Tubifera tenax* (L.)
*Tubifera tenax campestris* (Mg.)

SCHIZOPHORA

ACALYPTERAE

**Conopidae**
*Occemyia luteipes* Camr.
*Physocephala burgessi* Will.

**Otitidae**
*Epiblatea* sp.
*Psairoptera similis* Cress.
*Pseudotephritis* sp.
*Seioptera vibrans* (L.)
*Stenopterina* sp.
*Tritoxa cuneata* Lw.

**Pallopteridae**
*Palloptera jucunda* (Lw.)
*Palloptera terminalis* (Lw.)

**Piophilidae**
*Mysetaulus bipunctatus* (Fln.)
*Piophila atrifrons* M. & S.
*Piophila xanthopoda* M. & S.

**Trupaneidae**
*Epochra canadensis* Lw.
*Myoleja rubida* Coq.

*Rhagoletis berberis* Cn.
*Rhagoletis symphoricarpi* Cn.
*Rhagoletis tabellaria* (Fitch)
*Tephritis pacifica* (Doane)
*Tephritis variabilis* Doane
*Trupanea microsetulosa* Mall.
*Zonosema setosa* (Doane)

**Lonchaeidae**
*Lonnchaea flavidipennis* Zett.
*Lonchaea marylandica* Mall.

**Lauxaniidae**
*Calliopum quadrisetosum* (Thoms.)
*Homoneura occidentalis nudifemur* (Mall.)
*Lauxania cylindricornis* (F.)
*Lauxania nigrimana* Coq.
*Minettia americanella* Shew.
*Minettia flaveola* (Coq.)
*Minettia lupulina* (F.)
*Sapromyza brachysoma* Coq.
*Sapromyza hyalinata* (Mg.)
*Sapromyza monticola* Mel.
*Sapromyza ouelleti* Shew.

**Tylidae (Calobatidae)**
*Cnodacophora nasoni* (Cress.)
*Paracalobata univitta* (Wlk.)

**Psilidae**
*Chyliza scrobiculata* Mel.
*Pseudopsila perpolita* Jhns.
*Psila nigricornis* Mg.
*Psila rosae* (F.)

**Sepsidae**
*Decachaetophora aeneipes* de Meij.
*Sepsis punctum violacea* Mg.

**Sciomyzidae (Tetanoceridae)**
*Limnia* sp.
*Melina albocostata* (Fln.)
*Melina nana* (Fln.)
*Melina tenuipes* (Lw.)
*Melina ventralis* (Fln.)
*Tetanocera nanciae* Brim.
*Tetanocera phylliphora* Mel.
*Tetanocera plebeja* Lw.
*Trypetoptera canadensis* (Macq.)

**Chamaemyiidae**
*Chamaemyia juncorum* (Fln.)
*Chamaemyia polystigma* (Mg.)
*Pseudodinia nitida* Mel.
*Pseudodinia varipes* Coq.

**Helomyzidae**
*Allophylla laevis* Lw.
*Amoebaleria flavotestacea* (Zett.) ?
*Eccoptomera simplex* Coq.
*Helomyza serrata* (L.)
*Oecothea fenestralis* (Fln.)
*Suillia apicalis* (Lw.)
*Suillia assimilis* (Lw.)
*Suillia barberi* Darl.
*Suillia limbata* (Thoms.)
*Suillia loewi* Garr.
*Suillia longipennis* (Lw.)

**Trixoscelidae**
*Trixoscelis frontalis* (Fln.)
*Trixoscelis fumipennis* Mel.

**Chromyidae**
*Chyromya concolor* Mall. ?
*Chyromya flava* (L.)

**Clusiidae**
*Acartophthalmus nigrinus* (Zett.)
*Clusiodes melanostoma* (Lw.) ?

**Opomyzidae**
*Geomyza monostigma* Mel.

**Ephyridae**
Notiphilinae
*Ilythea spilota* Curt.
*Psilopa compta* (Mg.)

Hydropotinae (Hydrelliinae)
*Hydrina debilis* (Lw.)
*Hydrina nigrescens* Cress.
*Hydrina opposita* (Lw.)
*Hydropota griseola* (Fln.)
*Lytogaster gravida* Lw.
*Nostima picta* (Fln.)
*Pelina compar* Cress.

Ephydrinae
*Limnellia stenhammari* (Zett.)
*Parydra incommoda* Cress.
*Parydra varia* (Lw.)
*Scatella laxa* Cress.
*Scatella tenuicosta* Coll. ?

**Sphaeroceratidae (Borboridae)**
*Borborus equinus* Fln.
*Leptocera* (*Collinella*) *fumipennis* Spul.
*Leptocera* (*Collinella*) *latiforceps* Sabr.
*Leptocera* (*Collinella*) *omega* Sabr.
*Leptocera* (*Collinella*) *suberecta* Sabr.
*Leptocera* (*Leptocera*) *fontinalis* (Fln.)
*Leptocera* (*Opacifrons*) *sciaspidis* Spul.
*Leptocera* (*Scotophilella*) *abundans* Spul.
*Leptocera* (*Scotophilella*) *dissimilicosta* Spul. ?
*Leptocera* (*Scotophilella*) *nigrifrons* Spul. ?
*Sphaerocera pusilla* (Fln.)

**Drosophilidae**
*Campichaeta micans* (Hend.)
*Chymomyza* sp.
*Diastata eluta* Lw.
*Diastata modesta* Mel.
*Diastata vagans* Lw.
*Drosophila funebris* (F.)
*Drosophila nigrohydei* P. & W.
*Drosophila occidentalis* Spen.
*Drosophila pseudoobscura* Frol.
*Drosophila suboccidentalis* Spen.
*Drosophila subquinaria* Spen.
*Drosophila testacea* v. Ros.
*Scaptomyza disticha* Duda
(=*graminum* auctt.)
*Scaptomyza terminalis* (Lw.)
*Stegana* sp.

**Agromyzidae**
*Cerodonta denticornis nigroscutellata* Strobl
*Ophiomyia pinguis* (Fln.)
*Phytagromyza orbitalis* (Mel.)

**Phyllomyzidae (Milichiidae)**
*Desmomyza confusa* Cn.
*Neophyllomyza quadricornis* Mel.
*Paramyia nitens* (Lw.)

**Chloropidae**
Oscinellinae
*Dicraeus incongruus* Ald.
*Dicraeus ingratus* (Lw.)
*Elachiptera costata* (Lw.)
*Elachiptera decipiens* (Lw.)

*Elachiptera flaviceps* Sabr.
*Oscinella frit* (L.)
*Oscinella frit nitidissima* (Mg.)
*Oscinella frit pusilla* (Mg.)
*Oscinella incerta* Beck.
*Oscinella magnipalpis* Beck.
*Oscinella umbrosa* Lw.
*Tricimba brunnicollis* (Beck.)

Chloropinae
*Chlorops* sp.
*Meromyza marginata* Beck.
*Thaumatomyia annulata* (Wlk.)
*Thaumatomyia glabra* (Mg.)

CALYPTERAE

**Muscidae**

Scatomyzinae (Cordylurinae)
*Cordilura latifrons* Lw.
*Cordilura vittipes* Lw.
*Megaphthalma americana* Mall.
*Megaphthalmoides unilineata* (Zett.)
*Parallelomma gracilipes* (Lw.)
*Pseudopogonota aldrichi* Mall.
*Scatophaga furcata* Say.
*Scatophaga stercoraria* (L.)

Anthomyiinae
*Chirosia idahensis* Stn.
*Eremomyia humeralis* Stn.
*Hydrophoria divisa* (Mg.)
*Hylemya alcothoe* (Wlk.)
*Hylemya antiqua* (Mg.)
*Hylemya brassicae* (Bé)
*Hylemya betarum* (Lint.)
*Hylemya cilicrura* (Rond.)
*Hylemya coenosiaeformis* Stn.
*Hylemya depressa* Stn.
*Hylemya fugax* (Mg.)
*Hylemya garretti* Huck.
*Hylemya hucketti* Ringd.
*Hylemya lasciva* (Zett.)
*Hylemya neomexicana* Mall.
*Hylemya octoguttata* (Zett.)
*Hylemya oppidans* Huck.
*Hylemya propinquina* Huck.
*Hylemya setiventris alternata* Huck.
*Hylemya testacea* Stn.
*Hylemya trivittata* Stn.
*Hylemya variata* (Fln.)
*Paraprosalpia silvestris* (Fln.)
*Paregle cinerella* (Fln.)
*Paregle radicum* (L.)
*Pegomya accutipennis* Mall.
*Pegomya anabnormis* Huck. ?
*Pegomya bicolor* (Wd.)
*Pegomya caesia* Stn. ?
*Pegomya cresca* Huck.
*Pegomya duplicata* (Mall.)
*Pegomya flavipalpis* (Zett.)
*Pegomya fuscicauda* Huck.
*Pegomya gilva* (Zett.)
*Pegomya intersecta* (Mg.)
*Pegomya lividiventris* Huck.
*Pegomya longicornis* Huck.
*Pegomya lunatifrons* (Zett.)
*Pegomya marginata* Huck.
*Pegomya partita* Huck.
*Pegomya rufipes* (Fln.)
*Pegomya solitaria* Stn.
*Pegomya unguiculata* Mall.
*Pegomya univittata* (v. Ros.)
*Pegomya vittigera* (Zett.)
*Pegomya winthemi* (Meg.)

Fanniinae
*Azelia* sp.
*Euryomma peregrinum* (Mg.)
*Fannia aerea* (Mg.)
*Fannia canicularis* (L.)
*Fannia fuscula* (Fln.)
*Fannia incisurata* (Zett.)
*Fannia postica* Stn.
*Fannia scalaris* (F.)

Lispinae
*Lispe tentaculata* (Deg.)

Coenosiinae
*Coenosia tigrina* (F.)
*Limosia aliena* (Mall.)
*Limosia nigrescens* (Stn.)
*Limosia rufibasis* (Stn.)
*Lispocephala alma* (Mg.)

Phaoniinae
*Alloeostylus conformis* (Mall.)
*Alloeostylus diaphanus* (Wd.)
*Dialyta pallida* Stn.
*Helina multiseriata* Mall.
*Helina oregonensis* (Mall.)
*Helina procedens* (Wlk.)
*Helina troene* (Wlk.)
*Hydrotaea armipes* (Fln.)
*Hydrotaea pilitibia* Stn.
*Lasiops septentrionalis* (Stn.)
*Limnophora* (*Spilogona*) *anthrax* Big.
*Limnophora* (*Spilogona*) *magnipunctata* (Mall.)
*Limnophora* (*Spilogona*) *novae-angliae* Mall.
*Mydaea discimana* Mall.
*Mydaea electa* (Zett.)
*Mydaea obscurella* Mall.
*Mydaea occidentalis* Mall.
*Myospila meditabunda* (F.)
*Ophyra leucostoma* (Wd.)
*Phaonia consobrina* (Zett.)
*Phaonia errans* (Mg.)
*Pseudolimnophora nigripes* (Desv.)
*Spilaria lucorum* (Fln.)
*Xenaricia fulva* (Big.)

Muscinae
*Eumesembrina latreillei* (Desv.)
*Graphomya maculata* (Scop.)
*Haematobia irritans* (L.)
*Hypodermodes solitoria* (Knab.)
*Musca domestica* L.
*Muscina stabulans* (Fln.)
*Stomoxys calcitrans* (L.)

**Metopiidae**

Calliphorinae
*Calliphora vicina* Desv.
*Calliphora vomitoria* (L.)
*Cyanus elongata* (Hough)
*Cynomyiopsis cadaverina* (Desv.)
*Eucalliphora lilaea* (Wlk.)
*Lucilia illustris* (Mg.)

Sarcophaginae
*Helicobia rapax* (Wlk.)
*Pseudosarcophaga affinis* (Fln.)
*Ravinia l'herminieri* Desv.
*Ravinia pusiola* (Wlp.)
*Ravinia stimulans* (Wlk.)
*Sarcophaga* (*Acanthodotheca*) *eleodis* Ald.

*Sarcophaga* (*Acridiophaga*) *falciformis* Ald.
*Sarcophaga* (*Boettcheria*) *cimbicis* (Tns.)
*Sarcophaga* (*Boettcheria*) *latisterna* (Park.)
*Sarcophaga* (*Fletcherimyia*) *fletcheri* Ald.
*Sarcophaga* (*Kellymyia*) *kellyi* Ald.
*Sarcophaga* (*Protodexia*) *hunteri* Hough.
*Sarcophaga* (*Sapromyia*) *cooleyi* Park.
*Sarcophaga* (*Sarcophaga*) *exuberans* Pand.
*Sarcophaga* (*Sarcophaga*) *nearctica* Park.
*Sarcophaga* (*Sarcotachinella*) *sinuata* Mg.
*Sarcophaga* (*Tephromyiella*) *atlantis* Ald.
*Sarcophaga* (*Thelyepticocnema*) *incurva* Ald.

Miltogramminae
*Euhilarella fulvicornis* (Coq.)
*Euhilarella pilosifrons* (Allen)
*Euselenomyia trilineata* (Wlp.)
*Metopia leucocephala* Rossi
*Parametopia lateralis* (Macq.)
*Taxigramma heteroneura* (Mg.)

**Cuterebridae**
*Cuterebra tenebrosa* Coq.

**Larvaevoridae**

Phasiinae
*Cylindromyia californica* Big.
*Gymnoclytia occidentale* Tns.
*Hemyda aurata* Desv.
*Leucostoma* (*Paradionaea*) *atra* Tns.
*Neocyptera dosiades* (Wlk.)
*Paraphasia nigra* Brks.
*Rhodogyne filiola* (Lw.)
*Sciasma nebulosa* Coq.

Dexiinae
*Mochlosoma validum* B. & B.?
*Ptilodexia neotibialis* (West)
*Rhamphinina confusa* West
*Trochilodes skinneria* Coq.

Phoroceratinae
*Admontia* (*Xenadmontia*) *degeeroides* (Coq.)
*Bessa harveyi* (Tns.)
*Crocuta* sp. (=*Siphona auctt.*)
*Cryptomeigenia nigripilosa* Cn.
*Dexodes nana* Cn.
*Exorista mella* (Wlk.)
*Homalactia harringtoni* (Coq.)
*Lasioneura bicolor* (Cn.)
*Patelloa pachypyga* (A. & W.)
*Patelloa reinhardi* (A. & W.)
*Phylacteropoda* sp.
*Plagiprospherysa parvipalpis* (Wlp.)
*Tachinomyia apicata* Cn.
*Tachinomyia nigricans* Webb.
*Tachinomyia variata* Cn.

Goniinae
*Achaetoneura frenchii* (Will.)
*Aplomya theclarum* (Scudd.)
*Belvosia canadensis* Cn.
*Carcelia reclinata* (A. & W.)
*Cyzenis festinans* (A. & W.)
*Dolichotarsus griseus* Brks.
*Euexorista futilis* (O.S.)
*Eufrontina spectabilis* (Ald.)
*Eumea caesar* (Ald.)
*Gonia* (*Knabia*) *frontosa* (Say)
*Huebneria imitator* (Sell.)
*Leschenaultia* (*Rileymyia*) *americana* B. & B.
*Lydella nigrita* (Tns.)
*Madremyia saundersii* (Will.)
*Nemorilla pyste* (Wlk.)
*Phryxe pecosensis* (Tns.)
*Pseudoperichaeta erecta* (Coq.)
*Winthemia militaris* (Wlsh.)
*Winthemia rufonotata* (Big.)

Larvaevorinae
*Archytas* (*Nemochaeta*) *lateralis* (Macq.)
*Argentoepalpus rufipes* Brks.
*Argentoepalpus signiferus* (Wlk.)
*Bombyliomyia flavipalpia* (Macq.)
*Cuphocera* (*Deopalpus*) *contigua* Rnh.
*Ernestia* (*Pseudomeriania*) *nigrocornes* (Toth.)
*Eulasiona nigra* Cn.
*Eutrichogena polita* Brks.
*Fabriciella* (*Fabriciodes*) *polisa* Toth.
*Fabriciella* (*Metapotachina*) *brevirostris* Toth.
*Fabriciella* (*Metapotachina*) *latifacies* Toth.
*Fabriciella* (*Nowickia*) *hispida* Toth.
*Fabriciella* (*Rhachogaster*) *algens* (Wd.)
*Fabriciella* (*Upodemocera*) *nitida* (Wlp.)
*Lypha* sp.
*Mericia nigropalpis* (Toth.)
*Metopomuscopteryx tibialis* (Coq.)
*Neothelaira chaetoneura* (Coq.)
*Pararchytas decisa* (Wlk.)
*Peleteria* (*Peleteriopsis*) *iterans* (Wlk.)
*Peleteria* (*Sphyromyia*) *apicalis* (Wlk.)
*Peleteria* (*Sphyromyia*) *bryanti* Cn.
*Peleteria* (*Sphyromyia*) *malleola* Big.
*Siphophyto neomexicana* Tns.
*Wagneria helyma* (Wlk.)

**Acknowledgments**

My grateful thanks are due to the following officers of the Division of Entomology, Science Service, Ottawa: G. P. Holland, G. E. Shewell, J. R. Vockeroth, J. F. McAlpine, and J. G. Chillcott. For determinations of Tabanidae I am indebted to L. L. Pechuman, Lockport, N.Y.

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## Scavengers and Parasites from a Used Wasps' Nest

In October 1955 Professor Kenneth Graham brought in from Langley an unusually large wasps' nest of the current season's making and kept it in a glass chamber. The nest was deserted so it was not possible to determine which species of yellow jacket constructed it; it was probably *Vespula arenaria* (Fab.), a common wasp at the coast.

During the autumn months some eight recognizable specimens of what was apparently *Ephestia elutella* (Hubner) and some small ichneumon flies emerged and died in the container. These were given to me by

Professor Graham the following spring. Unforunately, Professor Graham needed this unusually large wasp nest for demonstration purposes, so I could not cut it up to determine the true status of the hymenopterans.

The small ichneumons were either parasitic upon the moth caterpillars or were *Sphecophaga burra* (Cresson), a parasite of wasp larvae. This insect, when it pupates spins across the wasp cell a silken sheet coloured like a poached egg with a brown instead of a yellow centre. The sheet is always slightly oblique and not straight across a cell.

From a small *Vespula* nest taken in the forest at 3100 ft. above Kamloops, I once obtained a number of small caterpillars which died without pupating. By cutting up the nest it was found that the larvae had acted as scavengers, feeding on the deposit of wasp larval frass that is always plastered against the base of each cell when the insect pupates. This deposit may be from one to three layers deep, depending upon how many larvae were reared in each cell, and is also fed upon by scavenging larvae of both the black carpet beetle and a dermestid, *Perimegatoma vespulae* Milliron, that develops in both animal and plant remains.

I have found that moths invade wasps' nests late in the season and develop in the upper, that is, the older comb layers. The ichneumon parasites usually develop in weak colonies; or if in strong colonies, only at the end of the season when the wasp population is declining. Neither moth larvae nor ichneumons seem to be interfered with by wasps.—*G. J. Spencer, University of British Columbia.*

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# CONTROL OF SOFT SCALES (HOMOPTERA: COCCIDAE) IN BRITISH COLUMBIA PEACH AND APRICOT ORCHARDS[1]

M. D. Proverbs[2]

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Within the last eight years there has been a marked increase in numbers of soft scales on peach and apricot trees throughout the Okanagan Valley of British Columbia. *Pulvinaria* sp. is most frequently found on peach; one species of *Lecanium,* designated as *Lecanium* sp. A in this paper, evidently prefers apricot, whereas another species of *Lecanium,* designated as *Lecanium* sp. D, has been found only on peach. At least two other species of soft scales are present on tree fruits in the interior of British Columbia, but so far they have not been particularly troublesome.

The *Lecanium* scales overwinter as small nymphs, about three-fourths of a millimetre in length. They grow very rapidly during April and May, and commence egg-laying early in June. The eggs hatch during June and July, the date varying somewhat with the species, locality, and season. The young summer nymphs move to the leaves where they feed; they make very little growth during the remainder of the season. Just before the leaves fall in the autumn, the nymphs move to one- to three-year-old branches, where they pass the winter.

The life-history of *Pulvinaria* sp. is very similar to that of the *Lecanium* species. However, it begins egg-laying about two weeks earlier than the *Lecanium* scales, and the eggs commence to hatch about mid-June. Unlike the *Lecanium* scales, many of the summer nymphs of *Pulvinaria* sp. move from the leaves back to small branches during summer, and many of them are almost half-grown by autumn.

The scales devitalize the trees, and may kill one- and two-year-old twigs. They secrete copious quantities of honey dew, which makes the fruit sticky and sometimes unmarketable.

Field experiments were conducted from 1949 to 1955 on the chemical control of the scales on peach and apricot trees in the Okanagan Valley. A survey was also made to determine what species of insects parasitize or prey on these scales.

## Materials and Methods

The following chemicals were used in the field experiments:

1. DDT, 50 per cent wettable powder; Pennsylvania Salt Manufacturing Company, Tacoma, Wash.
2. Demeton (Systox), 42.4 and 50 per cent liquids; Geary Chemical Company, New York, N.Y.
3. Diazinon, 25 per cent wettable powder of *O, O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate; Geigy Chemical Corporation, New York, N.Y.
4. Dieldrin, 50 per cent wettable powder; Shell Chemical Corporation, New York, N.Y.
5. Endrin, 18.5 per cent liquid; Shell Chemical Corporation, Julius Hyman Division, Denver, Colo.
6. Heptachlor, 25 per cent liquid (two pounds of heptachlor per U.S. gallon); Velsicol Corporation, Chicago, Ill.
7. Isolan, 25 per cent liquid of dimethyl 5 - (1 - isopropyl - 3 - methyl - pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.
8. Lime-sulphur, liquid; specific gravity 1.28; Oliver Chemical Company, Penticton, B.C.
9. Lindane, two 25 per cent wettable powders, one from Pennsylvania Salt Manufacturing Company, Tacoma, Wash., and the other from California Spray-Chemical Corporation, Richmond, Calif.
10. Malathion, 50 per cent liquid; American Cyanamid Company, New York, N.Y.; 25 per cent wettable powder; Pennsylvania

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1. Contribution No. 3670, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Entomologist.
3. All parasites were determined by Dr. O. Peck, Entomology Division, Ottawa.
4. Determined by Mr. J. F. McAlpine, Entomology Division, Ottawa.

Salt Manufacturing Company, Tacoma, Wash.

11. Nicotine sulphate, 40 per cent liquid; The N. M. Bartlett Spray Works, Beamsville, Ont.

12. Parathion, 15 per cent wettable powder; Naugatuck Chemicals, Elmira, Ont.

13. Polyethylene glycol, 600 mono ester of refined tall oil, liquid; The Emulsol Corporation, Chicago. Ill.; 600 mono laurate, liquid; Glyco Products Company, Incorporated, Brooklyn, N.Y.

14. Pyrenone T-503, liquid containing (w/v) 0.4 per cent pyrethrins, two per cent rotenone, and four per cent piperonyl cyclonene; U.S. Industrial Chemicals, Baltimore, Md.

15. Pyrolan, 40 per cent liquid of dimethyl 5-(3-methyl-1-phenyl-pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.

16. Soap, powder; Lever Bros., Montreal, Que.

17. Sodium lauryl sulphate, 42 per cent powder; Canadian Industries Limited, Montreal, Que.

18. Stove oil; 34 S.S.U. Vis. 100°F., over 75 per cent U.R., Shell Oil Company, Penticton, B.C.

19. Strobane, 42 per cent liquid of terpene polychlorinate with a chlorine content of approximately 66 per cent; B. F. Goodrich Chemical Company, Cleveland, Ohio.

20. Toxaphene, 40 per cent wettable powder; Hercules Powder Company, Wilmington, Del.

21. Trithion 4E, liquid containing four pounds of *S*-(*p*-chlorophenylthio) methyl *O, O*-diethyl phosphorodithioate per U.S. gallon; Stauffer Chemical Company, Mountain View, Calif.

22. Washing soda, crystalline sodium carbonate ($10H_2O$); Church and Dwight Company, Montreal. Que.

Sprays were applied by high-pressure, hand-gun equipment, by air-blast, concentrate sprayers, and, in one instance, by bucket-pump sprayer. As a rule, there were at least eight trees per treatment, but treatments were replicated in only a few instances. Experiments were conducted when the insects were in various stages of development: over-wintered nymphs, mature and almost mature scales, and summer nymphs. Control was determined by one of the following methods: (1) As soon as the spray deposits were dry, scale-infested twigs were taken to the laboratory and the cut ends of the twigs immersed in water. Scale mortalities were recorded two to three weeks later. (2) Two to three weeks after spraying, scale-infested twigs were pruned from the trees, and scale mortalities immediately recorded. (3) The number of scales per leaf was recorded before, and about two weeks after, spraying. Later, when it was found that dead scales remained attached to the leaves, the pre-spraying count was omitted and both living and dead scales were recorded in the post-spraying count. (4) As a rule, no counts were made of living and dead scales where the chemicals gave almost perfect control or very little or no control. In such instances, degree of effectiveness was estimated in the field by visual observation.

The species of parasites and predators present were determined by collecting, throughout the growing season, scale-infested twigs from peach and apricot orchards in the interior of British Columbia. The twigs, their cut ends immersed in water, were kept in battery jars in an insectary. Adult parasites that emerged from the scales were removed from the jars every day, and mounted on points for subsequent identification.

## Results and Discussion

### Chemical Control of *Lecanium* sp. A

**Overwintered Nymphs**—Mortalities of small, overwintered nymphs of *Lecanium* sp. A one month after apricot trees in the dormant stage were sprayed with lime-sulphur, or with lime-sulphur plus nicotine sulphate, were:—

| Material | Gallons per acre | Average scale mortality, % |
|---|---|---|
| Lime-sulphur | 20 | 43 |
| Nicotine sulphate, 40% | 1 | |
| Lime-sulphur | 20 | 33 |
| Check | — | 7 |

Mortality for each treatment was based on 500 scales; one twig was sampled from each of five trees.

When Diazinon or malathion was applied to peach trees showing ten per cent full bloom, mortalities of overwintered nymphs of *Lecanium* sp. A two weeks later were:—

| Material | Pounds per acre | Average scale mortality, % |
|---|---|---|
| Diazinon, 25% | 12 | 97 |
| Malathion, 25% | 15 | 95 |
| Check | — | 23 |

Mortality for each treatment was based on 1000 scales; one twig was sampled from each of ten trees.

Despite the fairly high mortality in the Diazinon and malathion plots, the trees became moderately sticky with honey dew during the last week in May. Evidently, where the initial scale infestation is severe, the rating for satisfactory commercial control should be greater than 97 per cent scale mortality.

Mortalities of overwintered nymphs of *Lecanium* sp. A were estimated to be between 30 and 60 per cent ten days after apricot trees had been sprayed at the calyx stage with various chemicals. Mortality was highest with 42.4 per cent demeton at 0.25 pints per 100 gallons and lowest with a mixture of 40 per cent nicotine sulphate at one pint plus washing soda at 0.5 pounds. Intermediate in effectiveness were 25 per cent Lindane at one pound, 15 per cent parathion at one pound, and a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol ester of tall oil at one quart. At the time of spraying, the scales were about twice as large as they were during the winter, and probably they were more difficult to control than earlier in the season.

**Mature and Almost Mature Scales** —A summer spray of 25 per cent Lindane at 1.5 pounds per 100 gallons was ineffective against mature and almost mature scales of *Lecanium* sp. A on apricot. The addition of one quart of stove oil to the spray mixture gave no improvement.

In another apricot orchard, several chemicals failed to give satisfactory control of *Lecanium* sp. A when about 75 per cent of the scales had started to lay eggs. Twenty-five per cent malathion at one pound per 100 gallons killed many of the adult scales, but was innocuous to the eggs. Twenty-five per cent Lindane at one pound per 100 gallons, 50 per cent demeton at 0.5 pints, 15 per cent parathion at 1.5 pounds, a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol mono laurate at one quart, or a similar dosage of nicotine sulphate plus 2.5 pounds of soap had no ovicidal value, and evidently killed fewer adults than the malathion spray.

**Summer Nymphs** — A post-harvest application of 40 per cent nicotine sulphate at 1.5 pints, plus stove oil at one pint, per 100 gallons killed exposed, summer nymphs of *Lecanium* sp. A on apricot trees, but did not kill nymphs that were protected by the shells of the mother scales, and had no effect on the eggs. After all eggs had hatched, and the nymphs had moved from under the mother scales, an additional spray of nicotine sulphate plus stove oil (the dosage of nicotine sulphate reduced to one pint) gave very good control. No counts were made, but living scales were found only after prolonged search.

In another apricot orchard (Table I), a post-harvet spray of malathion gave excellent control of summer nymphs. However, a nicotine sulphate-stove oil mixture did not give as good control as in the previous experiment. This mixture has very poor residual properties, and was probably ineffective against most of the nymphs that moved from under the mother scales after spraying. With the possible exception of parathion, the other chemicals that were applied were not promising.

In another experiment in the same orchard (Table II), a post-harvest spray of malathion once again gave excellent control of summer numphs. As in the previous experiment, control with nicotine sulphate was not satisfactory, presumably because many of the nymphs were protected by the mother scales. The addition of stove oil to nicotine sulphate evidently did not increase the effectiveness of the latter.

In a third apricot orchard, mortalities of summer nymphs were greater than 99.8 per cent 19 days after a post-harvest spray of 25 per cent Diazinon at two pounds, 25 per cent malathion at two pounds, or 25 per cent Trithion at one pint per 100 gallons. Mortality in the check plot was five per cent.

**TABLE 1.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks after, a Post-harvest Spray of Various Chemicals to Single Apricot Branches by Bucket-pump Sprayer.**

| Material | Amount per 100 Gal. | Nymphs per Leaf[1] Before Spraying | After Spraying |
|---|---|---|---|
| Malathion, 50% | 1.3 pints | 27 | 0.05 |
| Parathion, 15% | 1.0 lb. | 12 | 0.9 |
| Demeton, 42.4% | 0.5 pints | 21 | 8 |
| Nicotine Sulphate, 40% | 2.0 pints | 17 | 11 |
| Stove oil | 2.0 pints | | |
| Sodium lauryl sulphate, 42% | 2.0 oz. | | |
| Isolan, 25% | 1.0 pints | 14 | 9 |
| Heptachlor, 25% | 1.5 pints | 27 | 15 |
| Dieldrin, 50% | 1.0 lb. | 35 | 27 |
| Endrin, 18.5% | 0.5 pints | 10 | 11 |
| Strobane, 42% | 2.0 pints | 40 | 50 |
| Pyrolan, 40% | 0.5 pints | 32 | 41 |
| Check | — | 33 | 44 |
| Pyrenone T-503 | 1.0 pints | 16 | 22 |

[1]Based on 20 leaves.

## Chemical Control of *Lecanium* sp. D

**Overwintered Nymphs**—Mortalities of overwintered nymphs of *Lecanium* sp. D 15 days after peach trees were sprayed with Diazinon or malathion at the pink stage of blossom development were :—

| Material | Pounds per 100 gallons | Average scale mortality, % |
|---|---|---|
| Diazinon, 25% | 2 | 99.8 |
| Malathion, 25% | 2 | 99 |
| Check | — | 10 |

Mortality for each treatment was based on 500 scales; one twig was sampled on each of ten trees.

Another section of the same orchard was sprayed by a concentrate machine. Mortalities of slightly larger nymphs of *Lecanium* sp. D one month after a "calyx" spray of Diazinon plus DDT, or malathion plus DDT, were :—

| Material | Pounds per acre | Average scale mortality, % |
|---|---|---|
| Diazinon, 25% | 16 | 98 |
| DDT, 50% | 12 | |
| Malathion, 25% | 16 | 82 |
| DDT, 50% | 12 | |
| Check | — | 3 |

Mortality for each treatment was based on 1000 scales; one twig was sampled on each of 20 trees.

**TABLE II.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks After, a Post-harvest Spray of Various Chemicals to Single Plots of Apricot Trees by Hand-gun Sprayer.**

| Material | Amount per 100 Gal. | Nymphs per Leaf[1] | |
|---|---|---|---|
| | | Before Spraying | After Spraying |
| Malathion, 50% | 1 pint | 25 | 0.04 |
| Nicotine sulphate, 40% | 1 pint | | |
| Stove oil | 2 pints | 28 | 10 |
| Sodium lauryl sulphate, 42% | 2 oz. | | |
| Nicotine sulphate, 40% | 1 pint | 45 | 17 |
| Washing soda | 8 oz. | | |
| Lindane, 25% | 1 lb. | 40 | 25 |
| Check | — | 37 | 38 |

[1]Based on 20 leaves from each of four trees.

Malathion plus DDT in the "calyx" spray did not give as good control of *Lecanium* sp. D as malathion alone in the earlier, "pink-bud" spray, even though the per-acre dosage of malathion was approximately 50 per cent greater (dosage at the pink-bud stage was approximately ten pounds per acre). Evidently the nymphs become more difficult to kill as they increase in size; at the calyx stage they were about 50 per cent larger than at the pink-bud stage.

## Chemical Control of *Pulvinaria* sp.

**Overwintered Nymphs** — Lime-sulphur at 20 gallons per acre, used alone or with 40 per cent nicotine sulphate at one gallon, did not give satisfactory control of overwintered nymphs of *Pulvinaria* sp. on apricot trees in the dormant stage. Thirty-nine days after spraying the percentage mortalities were: Lime-sulphur, 89; lime-sulphur plus nicotine sulphate, 65; check, 5. The low mortality in the lime-sulphur-nicotine sulphate plot was doubtless partly due to poor spray coverage. A moderately strong wind was blowing when most of the trees in that plot were sprayed.

**Mature and Almost Mature Scales** — A mixture of 40 per cent nicotine sulphate at one pint, plus washing soda at 0.5 pounds, per 100 gallons, applied to peach trees at the calyx stage, had no observable effect on mature and almost mature scales of *Pulvinaria* sp. A similar quantity of nicotine sulphate, plus polyethylene glycol ester of tall oil at one quart, was equally ineffective. Fifty per cent malathion at 1.3 pints per 100 gallons, applied to apricot trees at about 90 per cent petal-fall, was also ineffective against these scales.

**Summer Nymphs**—Fifteen per cent parathion at 0.75 pounds per 100 gallons gave good control of *Pulvinaria* sp. nymphs on peach trees during June. Forty per cent nicotine sulphate at one pint plus soap at three pounds was not quite so effective. The sprays were applied when about 75 per cent of the eggs had hatched. Evidently parathion was sufficiently persistent to continue killing nymphs that emerged some days after spraying, whereas this was not so with nicotine sulphate. Very few scales were killed by 25 per cent Lindane at one pound per 100 gallons, or by 40 per cent toxaphene at 2.5 pounds.

## Parasites and Predators

Parasites reared from *Pulvinaria* sp. and *Lecanium* spp. in the Okanagan Valley include *Coccophagus scutellaris* (Dalm.), *Aphycus kincaidi* (Timb.), and *Aphycus* sp. near *californicus* How. *Lecanium* spp. were also parasitized by *Coccophagus lycimnia* (Wlkr.) and *Microterys* sp.[3] Larvae of a predacious fly, *Leucopis* sp.[4], were found devouring large numbers of *Lecanium* eggs. Unfortunately, this predator was sometimes parasitized by *Pachyneuron eros* Gir. Various coccinellids (species not determined) attack soft scales in the Okanagan Valley, and anthocorids were seen feeding on *Lecanium* spp. in the laboratory. In the spring, birds of the finch family were observed feeding on overwintered nymphs of *Lecanium* spp.

## Summary

In experiments from 1949 to 1955 in British Columbia peach and apricot orchards, a post-harvest spray of malathion, Diazinon, or Trithion gave excellent control of summer nymphs of *Lecanium* sp. A on apricot trees. Diazinon or malathion, at the pink-bud stage of peach, also gave good control of small, overwintered nymphs of *Lecanium* sp. D, but was not quite so effective against slightly larger nymphs of *Lecanium* sp. A at ten per cent full bloom. A summer spray of malathion, parathion, nicotine sulphate plus soap, nicotine sulphate plus polyethylene glycol mono laurate, lindane, lindane plus stove oil, or demeton did not give satisfactory control of mature and almost mature scales of *Lecanium* sp. A. Summer nymphs of *Pulvinaria* sp. were controlled in June by one application of parathion; both Lindane and toxaphene were ineffective. At least five species of Hymenoptera and one species of Diptera attack soft scales on peach and apricot trees in the Okanagan Valley.

### Acknowledgments

Thanks are due to Mr. G. D. Halvorson of the Summerland Laboratory, and to Mr. H. A. Magel, now at the Canada Experimental Farm, Agassiz, B.C., for their assistance in the application of the sprays.

# A NOTE ON SEXING LIVE SPECIMENS OF *SCOLYTUS UNISPINOSUS* LEC. (SCOLYTIDAE, COLEOPTERA)[1]

M. D. ATKINS and L. H. MCMULLEN[2]

A method for rapid, accurate determination of insect sex is often a valuable asset in field studies. Several sex differences, including one common to many species of *Scolytus*, and the results of testing their validity for field use, are presented here for *Scolytus unispinosus* Lec., the Douglas-fir engraver beetle.

In recent work it was necessary to determine the sex of a number of Douglas-fir engraver beetle adults in the field without injuring them. This led to an examination of adults under the microscope which revealed three differences in the external morphology of the sexes.

The first difference noticed in the attacking adults, was that the frons of the male bore a denser crown of setae than that of the female. This characteristic was used to sex 60 adults with a 10x hand-lens and then under 40x with a stereoscopic microscope. Subsequent dissections revealed that 14 errors were made with the hand lens, while only one was made using the microscope. The value of this characteristic is reduced after the beetles have been engaged in gallery construction, as the head setae become considerably worn.

A stable and reliable difference was found in the shape of the head as described for most members of this genus (Blackman, 1934). When viewed laterally, the front of the female's

1. Contribution No. 378, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
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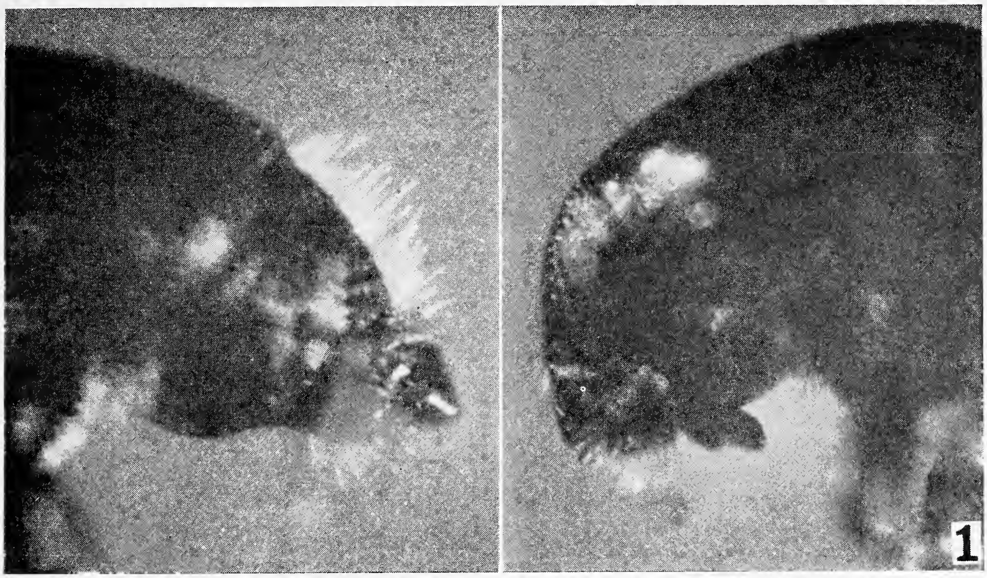

Fig. 1.—Heads of male (left) and female (right) *Scolytus unispinosus* Lec., showing difference in shape and setation.

head is convex while that of the male is sloping and flattened to a point well behind the eyes. Both head shape and setation differences are shown in Fig. 1.

A sample of 40 beetles was sexed by the authors under 40x, using head shape as the differentiating character. Later dissections showed that no errors were made. As microscopic examination is inconvenient for field identification, two more samples were sexed with a 10x hand lens. Dissection showed that out of 65 beetles, only 3 were sexed incorrectly.

The third interesting sex difference results from behaviour. Once gallery construction has begun, and the male has assumed its duty of kicking the boring dust from the entrance hole, small particles of white frass adhere to the posterior sternites which form the posterior, ventral concavity (Fig. 2). As some males leave their galleries while new attacks are still being made, one cannot only tell the sex of the individuals, but also some of the past history of males by this observation.

Two interesting sidelights of the examination were the discovery of nematodes densely packed in the abdominal cavity of about 15 per cent of the adults, and the presence of a large hymenopterous larva in the abdominal cavity of 2 specimens.

**Reference**

Blackman, M. W. 1934. A revisional study of the genus *Scolytus* Geoffroy (*Eccoptogaster* Herbst) in North America. U.S.D.A. Technical Bulletin 431, 1-30.


Fig. 2.—Ventral view of male *Scolytus unispinosus* Lec., showing boring dust adhered to sternites of posterior ventral concavity.

# NOTES ON SOME HEMIPTERA WHICH HAVE BEEN INTRODUCED INTO BRITISH COLUMBIA

W. Downes
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In spite of the best efforts of the inspection service, foreign insects find their way into this province from time to time and some from eastern Canada and the United States. While frequently species which are most unwelcome obtain access, we have, within the last fifty years, received some which may prove of distinct economic value. My remarks are based upon experience in collecting Hemiptera in British Columbia since 1917.

*Phytocoris tiliae* L. This handsome Mirid has probably been present in British Columbia for a considerable time. It is fairly common in Britain and belongs to a family known to be largely predaceous in habit. Usually it is brightly mottled with light green and black. It is to be found on tree trunks, especially deciduous trees, and occasionally on wooden fences. In 1918 to 1923 I found it common on boulevard trees in Vancouver's west end at the food of Georgia and nearby streets, often accompanied by the slender thread-legged bug, *Empicoris pilosus* (Fieb.), another predaceous species. In 1954 I looked for it again in Vancouver and found it abundant on two decaying deciduous trees at the foot of Robson Street, on this occasion accompanied by numbers of another *Phytocoris* species new to B.C., (apparently the European *P. dimidiatus*, but not yet definitely identified). Although present on the mainland for such a long period *P. tiliae* has not yet been found on Vancouver Island.

*Melanotrichus concolor* Kbm. This is another European Mirid which feeds on broom, *Cytisus scoparius*. The insect is green, of about the same shade as the host. This species was first noticed on Vancouver Island in the late twenties. It is said not to be very abundant in Britain, but on Vancouver Island it swarms on the broom bushes to which it is definitely injurious.

*Heterotoma meriopterum* Scop. This curious Mirid is a European species which was recorded by Knight in 1917 from New York and is now found in British Columbia. It is very common on Southern Vancouver Island and the lower mainland. We took it first at Cedar Hill, Victoria, in 1933 where it was swept from broom bushes; but it is abundant on almost any kind of herbage and brush. It is dark brown or black and can be recognized at once by the first two joints of the antennae being swollen and thickly clothed with dark hairs; the third and fourth joints are bare and filiform. Little or nothing seems to be known of its life history but it does not appear to be harmful in any way.

*Dicyphus pallidicornis* Fieb. This European species was sent to me from Vancouver in 1944, but it has been present in Western North America for a considerable time, having been previously reported from Oregon. Its only known host is *Digitalis,* and if it confined its attentions to the common garden foxglove no great harm would be done. But it also attacks the medicinal Digitalis which is grown in some quantity in the Victoria district, and damages the plants extensively. It can be controlled by spraying with DDT. There are several generations during the summer; the last generation is usually brachypterous and hibernates among dead leaves and at the base of the plants. The species is abundant up and down the coast of British Columbia wherever foxgloves are grown.

*Campyloneura virgula* Fieb. This pretty species is allied to *Dicyphus* which it closely resembles. It is a native of Europe where it is known to be an efficient mite destroyer. My first record of it was in 1949 at Goldstream on Vancouver Island where it was swept from alder trees and nettles.

It has since been taken in small numbers at various points near Victoria and on the lower mainland. The insect is yellowish, the wings hyaline tinged with yellow, the thorax with a broad band of yellow, the base of the scutellum yellow, the apex white. The cuneus is bright yellow, the apical portion orange-red. I have swept it from alders, poplars and various kinds of brush. It may prove to be a useful addition to our fauna.

*Orius minutus* L. This small Anthocorid was discovered by Norman Tonks on Lulu Island on the lower mainland in 1951 on raspberries and logans. It is a European species common in Britain. Our only known native species is *Orius insidiosus* from which *minutus* is readily distinguished by its overall brown colour and broader outline. *O. minutus* is predaceous on mites and small insects and may prove to be a useful species. So far the lower mainland is the only locality record.

*Gargara genistae* Fab. This is one of the only two species of treehoppers found in Britain. It has previously been known to occur in New Jersey where it was taken in 1917. In 1934 I took it at Cedar Hill, Victoria, on broom. Since that time *G. genistae* has spread to Goldstream eleven miles west. It is not known to be injurious.

*Arytaina spartiophila* (Forst.). In 1949 this Psyllid occurred in enormous numbers on broom, *Cytisus scoparius*. That was the first year it had been recorded in British Columbia. It has been introduced from Europe and was first recorded at Fort Lewis, Washington, in 1935. When in large numbers it does heavy injury to broom. This is not entirely to be deplored since, over the years, broom has formed dense thickets, often eight feet high on the Goldstream hills. Such thickets are a fire hazard, and effectually smother second growth. A check to the advance of broom may prove to be an advantage. Many areas formerly in grass are now covered with broom.

*Graphocephala coccinea* (Forst.). This leafhopper, which is common in Eastern Canada in shady woods, was numerous on rhododendrons at a nursery outside Victoria in 1941. It is strikingly marked with broad stripes of red and green. It does not seem to have spread in the Victoria area, but may still be present on rhododendron.

*Stictocephala bubalus* (Fab.). The buffalo treehopper was not known as a native species in this province prior to 1920, when I received a specimen collected on the Agassiz Experimental Farm where it had probably been introduced on nursery stock. A few years later *S. bubalus* appeared in the southern Okanagan, but this may have been a separate introduction. The species is now well established. It does harm to several kinds of fruit trees by ovipositing in the twigs.

*Stictocephala diceros* (Say). This is recorded only from Agassiz, B.C., from where I received a number of specimens in 1925 and 1926, but none since. It does not appear to have spread, and has never been recorded from interior districts. It was probably introduced from eastern Canada in nursery stock.

*Macropsis fuscula* Zett. This European species appeared on logans and raspberries on Lulu Island in the lower Fraser Valley in 1952 and within a year increased to enormous numbers. By 1954 it had spread 30 miles up the Fraser Valley where it was found on varieties of wild *rubus*. The introduction of this species is most unfortunate on account of the hazard to the loganberry industry. It has already spread to Vancouver Island, which was to be expected, since the site of the original infestation is close to the airport. Without such artificial means of distribution it might have been confined to the lower mainland for a long period as has been the case with other species. This occurrence has been adequately reported elsewhere by H. Andison (Can. Ins. Pest Rev. 32(1): 4. 1954).)

*Macropsis virescens var. graminea* (Fab.). This was first taken by me at Haney on poplars in 1954. It is a European species now widely distributed in North America but is not expected to prove of any particular economic importance.

*Idiocerus decimusquartus* Schr. This name now takes precedence in the case of this leafhopper which was long known as *Idiocerus scurra*. It is another denizen of poplar trees and is known to have been present on the lower mainland since 1922, when I received a specimen collected at New Westminster. This is a European species, present in North America for a long time, which may have come to British Columbia in the egg stage in the first poplars brought here. Like several other species it has apparently not yet succeeded in crossing to Vancouver Island.

*Allygus mixtus* (Fab.). This large handsomely marked European leafhopper was first noticed on Vancouver Island in 1948, but probably it had arrived some years earlier since it was already well distributed over the southern districts. It is an active flier, so its spread could be quite rapid. It now occurs on the mainland, breeding on oak and other deciduous trees and on snowberry (*Symphoricarpus*). So far it has not proved injurious.

There are several other species which have been edging their way across the continent for years, but cannot be mentioned here. Others will, no doubt, continue to arrive; it is some comfort to know that, in the case of Hemiptera, many are harmless, and some are definitely beneficial.

## An unusual flight of termites

Emergence of alate first reproductives of the most commonly occurring termite in the lower Fraser Valley, *Zootermopsis angusticollis* Hagen, may occur during almost any month of the year (Jacob, J. K. The Termites of British Columbia, their structure, bionomics and intestinal fauna. Unpublished Masters' Thesis, University of British Columbia, 1938). I have personally observed them from January to May and from August to November. For some years now I have watched the autumn flight along the north slope of the Point Grey Peninsula any time between the end of August, through September. These termites abound in old logs that lie half buried in sand or gravel in various stages of decay on both sides of Burrard inlet. They are in a surprisingly high percentage of older homes in the Kerrisdale-Kitsilano area and may occur almost anywhere in Vancouver where earth is in contact with the stucco or wooden siding of a house and rot sets in. Garages whose flooring rests on timbers directly in contact with the earth and buildings with damp, dead-air spaces below them, are particularly susceptible.

The autumn flight of termites along the Point Grey peninsula can be directly followed by the movements of large flocks of Bonaparte's gulls (*Larus philadelphia* Ord.) which pluck the termites out of the air. Professor Cowan told me that he has shot the birds during these manoeuvres and has found them packed with termites. One-time residents of Gambier Island have assured me that they have frequently watched this behaviour amongst large gulls also, so it is probably general along our coasts wherever termites swarm. Normally, off Point Grey, this flight occurs from 300 to 500 feet above ground and extends inland from the sea beaches for possibly one quarter of a mile. But in the early evening of August 1, 1956, an unusually large number of these delicate, black-headed gulls hunted termites from the sea shore inland and overhead until they passed southwards out of sight. The line of diving, twisting gulls stretched east and west as far as one could see, at about the height of tall, old fir trees nearby, which would be between 150 and 200 feet. Five days later some residents of South Burnaby described to me this flight of gulls stating that it had come from the north and had passed southwards over the Fraser River and out over Lulu Island.

In past years, it would seem that the supply of winged termites gave out within a few hundred yards of the sea shore but the flight of termites on August 1, 1956, must have exceeded all previous ones to have supplied the birds with food for several miles.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

# SOIL INSECTICIDES FOR CONTROL OF THE TUBER FLEA BEETLE, *EPITRIX TUBERIS* GENT., IN THE LOWER FRASER VALLEY OF BRITISH COLUMBIA[1]

H. G. Fulton[2]

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The tuber flea beetle, *Epitrix tuberis* Gent., was first reported from the southwestern coastal area of British Columbia in 1940. The losses resulting from the larval feeding in tubers were severe, so that it was necessary to develop control measures. This is a summary report on experiments to destroy larvae conducted mainly from 1947 to 1955 on clay loam, sandy to gravelly loam, and silt soils in the Agassiz and Chilliwack areas. The work was carried on under the direction of Mr. R. Glendenning, Officer-in-Charge, Entomology Laboratory, Agassiz, until his retirement in 1953, and was continued by the writer after that time.

Early experiments showed that a thorough application to potato foliage of DDT and calcium arsenate, or DDT alone, reduced damage to the tubers by destroying the beetles. However, this method of control sometimes failed when materials were not applied early, often, or thoroughly enough or when weather conditions were unfavorable. The economic advantage of foliar application is that insecticides may readily be combined with sprays which are routinely applied to control late blight.

An experiment in 1944 on the value of five materials applied to the foliage showed that tuber damage was by no means proportional to the numbers of adults. With the advent of stable organic insecticides effective against soil insects, experiments were conducted on ways of killing the larvae.

Preliminary tests in 1945 and 1946 with both field- and pot-grown potatoes showed that neither calcium arsenate nor cryolite was effective as a larvacide in the soil. The best control was obtained with dust containing DDT and calcium arsenate applied to the foliage.

Experiments in 1947 showed that BHC from different sources applied to the surface and worked into the soil by various methods gave excellent control, but caused phytotoxicity at certain rates. Stored tubers from all the BHC plots developed the characteristic taint and were very distasteful by spring.

In 1948 similar experiments with BHC confirmed the previous year's results. DDT in the soil did not give any control. The standard control remained a dust of DDT and calcium arsenate on the foliage.

Tests in 1949 showed that soil pH had little or no effect on the control achieved with either crude or refined BHC, nor did acidity or alkalinity prevent tainting. Good control was achieved with chlordane worked into the soil. Four applications of the standard control proved insufficient, possibly because the first application was not made soon enough.

In 1950, single applications of chlordane, aldrin, and lindane broadcast and incorporated into the soil at various rates were compared with DDT and methoxychlor applied to the foliage. The soil treatments gave excellent control, but four foliage treatments with DDT or methoxychlor were not effective. Tubers from the plots treated with lindane were condemned because they were off-flavored.

In 1951, one of the two experiments intended to check the data on single soil applications of aldrin and chlordane was a failure because of poor

1. Contribution No. 3587, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Officer in Charge.

tillage. The area occupied by the experimental plots had been the site of permanent hedgerows of evergreens for many years. These had only recently been removed and it was impossible to put the soil in a condition of good tilth. The other experiment demonstrated 97 per cent control with aldrin at 2½ pounds per acre.

No experiments were set up in 1952 because the question of residue hazards had not been settled.

In 1953, replicated experiments were conducted with aldrin, dieldrin, and heptachlor dusts and granular heptachlor, each at 3.6 pounds of toxicant per acre and incorporated into the soil in a 12- to 14-inch band along the row. The best control was 77 per cent with aldrin, which indicated that the insecticides should be distributed in a wide band, as better control had been obtained with aldrin broadcast at lower rates. Granular heptachlor gave only 47 per cent control; the carrier used was later found to have contributed to a rapid loss of toxicity. Chlordane was not tested in 1953 because of limitations of space and labor.

**TABLE I.—Percentages of control of the tuber flea beetle after single soil applications of various insecticides by three methods, Sardis, B.C., 1954.**

| Material | Toxicant per Acre, pounds | Method of application | Infestation index | Control % |
|---|---|---|---|---|
| Aldrin, 2.5% dust | 4 | Broadcast, deep working | 6.87 | 95.0 |
| | 4 | Broadcast, shallow working | 5.62 | 95.8 |
| | 2 | 6-inch band, shallow working | 33.75 | 75.4 |
| Aldrin, 5.0% granular | 4 | Broadcast, deep working | 9.25 | 93.1 |
| Heptachlor, 2.5% dust | 4 | Broadcast, deep working | 4.50 | 96.6 |
| | 4 | Broadcast, shallow working | 12.50 | 90.6 |
| | 2 | 6-inch band, shallow working | 20.75 | 84.4 |
| Check | | No treatment | 133.25 | 0 |
| Difference necessary for significance at 5% level | | | | 16.5 |

[1]Average for 100 tubers taken at random from each of 4 replicate plots, washed, and weighted as follows according to 4 categories of damage: clean, up to 3 light injuries, 0; light, 4 to 15 feeding marks, 1; medium, 16 to 30 feeding marks, 2; heavy, over 30 feeding marks, 4. Clean and light categories marketable. Maximum infestation index: 400.

In 1954, tests were conducted on shallow and deep incorporation of aldrin and heptachlor dusts and granular aldrin after broadcasting, and on a narrow, 6-inch band treatment with the two dusts. Table I shows that the broadcast treatments gave excellent control. There was no significant difference between materials worked into the soil deeply with a rotary cultivator and those worked in shallowly with a hand rake. The band treatment was more economical but significantly less effective.

In 1955, dusts of aldrin, dieldrin, heptachlor, and chlordane were each tested at three rates to establish minimum dosages. Before planting, the dusts were broadcast on the surface and worked into the soil by light hand raking. The rates in pounds per acre were: aldrin and heptachlor, 4, 3, and 2; dieldrin, 2, 1½, and 1; chlordane, 10, 7½, and 5. An unusually light infestation helped to reduce to insignificance the differences between the treatments, which were all at or close to 100 per cent effectiveness. No experiments were conducted in 1956.

### Summary

Experiments from 1940 to 1955 on clay loam, sandy to gravelly loam, and silt soils showed that satisfactory protection of potatoes from larvae of the tuber flea beetle can be obtained by broadcasting and incorporating a single application of one of several chlorinated hydrocarbons into the soil before planting. Effective materials were: aldrin, dieldrin, heptachlor, and chlordane. Incorporating the insecticide into the soil over the entire area was superior to either narrow or wide band application. No apparent differences in control were noted with deep or shallow incorporation. BHC and lindane caused off flavors in the tubers during storage. Given soil in good tilth, soil treatment is simpler and more reliable than foliar applications, although the latter are still popular because the insecticides can be applied in the spray necessary to control late blight.

## ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART VII — *APATELA* SPP. (NOCTUIDAE)[1]

D. A. ROSS[2] *and* D. EVANS[3]

More than 20 species of *Apatela* (*Acronycta*) are known to occur in British Columbia. The larvae feed on deciduous-leaved trees, shrubs, and herbs, and, although occasionally numerous, are of little or no economic importance. No severe tree defoliation by species of *Apatela* has been reported in British Columbia. The larvae have the typical body structure of garden cutworms; unlike the common cutworms, a number of species are clothed with medium to very long, sparse to dense hairs. Body colours are: green and brown, yellowish, brown, or black. The *Apatela* larval head is slightly bilobed; it bears primary setae only.

Most, if not all, local species overwinter in the pupal stage within cocoons in the bark or on the ground.

**A. dactylina** Grote. *Salix* spp.; Southern Interior, notably along the Big Bend Highway, between Revelstoke and Mile 80; found also on *Alnus tenuifolia* at Aleza Lake and Yard Creek. **Larva:** 2½ inches long; head glossy black; body blackish, with dorsal transverse bands of short brush-like orange hairs; hairs on sides yellowish; dorsal, closely-paired pencils of long black hairs on $A_1$, $A_3$ and $A_8$.

**A. lepusculina** Gn. *Populus tremuloides, Salix* spp.; Central and Southern Interior and Vancouver Island. **Larva:** 1¼ inches; head black with some whitish markings on frons and sides; body yellowish or greenish excepting blackish venter and dorsal stripe; clothed with soft, long yellow hairs; black pencil tuft on abdominal segments 1, 3, 4, 5, and 8.

**A. leporina** L. *Populus tremuloides, P. trichocarpa, Salix* spp.; Cuisson Creek Quesnel, Castle Rock, and Cluculz Lake. **Larva:** 1¼ inches; head and body greenish-white; clothed with very long, curved white or yellowish hairs (curved forward on one side, backward on the other) and a few black ones at the end of the abdomen; there may be 3 to 5 black dorsal spots on the dorsum of the abdomen, vestiges of black pencil tufts that occur in early instars.

**A. innotata** Gn. *Betula papyrifera;* Central and Southern Interior. **Larva:** 1½ inches; top of head reddish-brown, front flesh-coloured, remainder blotched with black; body brown, tinged with blue and purple; small "warts"

1. Contribution No. 376, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
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on dorsum black, pale centred; "warts" on sides white; yellow spot between each set of setae i and ii; clothed with rather sparse medium long grey hairs.

**A. radcliffei** Harv. *Prunus emarginata, Amelanchier* sp., *Sorbus occidentalis;* Narcosli Creek, China Creek, Oyama and Revelstoke and Vancouver Island. **Larva:** 1½ inches; upper half of head reddish-brown, remainder black; pronotal shield black; dorsum and venter of body purplish-brown or blackish; sides, dorsal, and subdorsal lines yellow; sparse medium to long hairs on body.

**A. grisea** Wlk. *Alnus* spp., *Salix* Spp., *Betula papyrifera, Prunus pennsylvanica* (1 record), *Corylus* sp. (1); Central Interior and Southern B.C., and Vancouver Island. **Larva:** over 1¼ inches; head brown, excepting green frons; body green; brown dorsal stripe widened posteriorly, enclosing green portion on $A_5$ to $A_7$, stripe edged in part with yellow; small brown patch about each spiracle and above each proleg and true leg.

**A. funeralis** G. & R. *Acer glabrum, Betula papyrifera, Salix* spp., *Alnus* sp.; Shuswap Lake, Hupel, Trinity Valley, Aleza Lake, Salvus. **Larva:** head and body black; an oval yellow to orange-coloured patch on dorsum of each body segment, those on the abdomen with a black transverse line through each; long black spatulate setae (seta ii) on the dorsum of abdominal segments 1 to 6 and 8 to 9; additional spatulate setae occur on the first thoracic segment.

**A. fragilis** Gn. *Betula papyrifera, B. occidentalis, Sorbus occidentalis, Amelanchier* sp., *Prunus* spp., *Salix* spp.; Central Interior, Southern B.C. and V. I. **Larva:** 1¼ inches; head green and brown; body green with broad brown dorsal patch on each segment; pale "warts" with sparse long hairs; no markings on sides of body.

**A. impleta** Wlk. *Alnus* sp., *Salix,* sp., *Populus* sp.; Alberni, Langford, V.I.; Rivers Inlet, Cinnemousun Narrows, Downie Creek.

**A. impressa** Wlk. *Salix* spp., *Alnus* sp.; Central B.C., and Yukon Territory. **Larva:** "reddish or tan head; body black, large yellowish and orange tubercles; yellowish and buff coloured setae". According to Forbes (1954) the larva has a red substigmatal line.

### Reference

Forbes, W. T. M. 1954. Lepidoptera of New York and Neighboring States — Noctuidae, Part III. Memoir 329, Cornell Univ. Agric. Exp. Sta.

## On the feeding preferences of *Perimegatoma vespulae* Milliron (Coleoptera: Dermestidae)

*Perimegatoma vespulae* Milliron was accidentally brought to the University during the middle thirties in insects that had been collected in the dry belt during the summer. Infestation apparently had occurred when the pinned insects were left out to dry before being put into store boxes.

Since *P. vespulae* is parthenogenetic one beetle loose in a museum room can reproduce without having to fly out of doors to feed, so notwithstanding utmost precautions, every now and then a larva turns up in a cabinet drawer. I have isolated a pupa of this beetle, placed it on powdered fox chow in a tight container, watched the beetle mature, emerge, lay eggs, and watched the eggs hatch to minute larvae, whose capacity to pass between the top of a store box and its lid is astonishing.

For the past ten years or so larvae of this beetle have also been brought down from the dry belt in botanical specimens. Infestation of this material seems to begin in the field during the drying process. When the plants are mounted and distributed to the steel herbarium cabinets, the larvae in the folders may feed undisturbed for long periods, and move to other folders.

When found thus, the larvae are catholic in their tastes, feeding upon petals, buds and leaves of many plants except conifers. However, for initial attacks the beetles appear to show preferences in this order:— Ranunculaceae; Scrophulariaceae, especially *Castilleja;* Compositae, especially *Solidago;* Saxifragaceae, especially *Ribes,* and Aceraceae, especially maple flowers.

I am indebted to Professor T. M. C. Taylor and to Dr. K. Beamish for noting the host preferences in the herbarium.

—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART VI — *PLUSIA* SPP. (NOCTUIDAE)[1]

D. A. ROSS[2] *and* D. EVANS[3]

Although some species of this genus of defoliators are common, none has been recorded in "outbreak proportions". Unlike most other genera of the Noctuidae, *Plusia* (*Syngrapha* and *Autographa*) larvae have, in addition to the anal prolegs, only two pairs of ventral prolegs. The larvae are green, with stripes and longitudinal strips of minute black spinules. Most species have black pinacula, at least on upper portions of the body. *Plusia* spp. overwinter as small larvae.

**P. rectangula** Kby. *Pseudotsuga taxifolia, Tsuga heterophylla, Abies lasiocarpa, Picea engelmanni, P. glauca, Pinus monticola* (1 record); Southern B.C. and Central Interior. **Larva:** 1 inch; fairly broad white addorsal and subdorsal stripes, the addorsal slightly broader than the subdorsal on central abdominal segments; spiracular stripe, white, edged dorsally with cream.

**P. alias** Ottol. *Picea engelmanni, P. glauca;* Southern B.C. and Central Interior. **Larva:** length, 1⅛ inches; addorsal, subdorsal and spiracular stripes, white, the subdorsal wider than the addorsal.

**P.** sp. nr. **alias.** *Picea glauca, P. engelmanni;* Southern and Central Interior. In correspondence, Hardwick stated the following about this form: " . . . while superficially resembling *alias,* they do not appear to be conspecific."

**P. celsa** Hy. Edw. *Tsuga heterophylla, Abies lasiocarpa, Abies grandis, Picea glauca* (1 record); Southern B.C. and Central Interior. **Larva:** addorsal, subdorsal, and spiracular stripes, white, the addorsal broader than the subdorsal although it may appear subequal; fairly prominent black pinacula.

**P. angulidens** Sm. *Abies lasiocarpa,* Penticton.

**P. selecta** Wlk. *Picea glauca, P. engelmanni, P. sitchensis, Pseudotsuga taxifolia, Abies lasiocarpa, Pinus contorta, Tsuga heterophylla* (2 records); Central Interior and Southern B.C.; common. **Larva:** length 1⅛ inches; head pale green, faintly dotted with brown; body uniform bright green with narrow white addorsal and subdorsal stripes, of equal width on the abdomen; addorsals very narrow on thorax; spiracular — subspiracular stripe, cream; small black pinacula. (One seta immediately above each meso- and metathoracic leg on *selecta,* two on *celsa* and *alias* [two also on *rectangula*]), McGuffin, 1954.

**P. epigaea** Grt. Two fully grown larvae have been collected and reared, one from *Populus tremuloides,* Cranbrook, the other from *Pinus contorta,* Salmon Arm. Jones (1951) notes the host as *Vaccinium* spp. **Larva:** 1 inch; head, pale green, black lateral line on head under ocelli; body pale green; addorsal, subdorsal (narrower than addorsal) lines and spiracular stripe, white; small pinacula, white not visible to naked eye; a single seta above each meta- and meso-thoracic leg.

**P. ampla** Wlk. *Alnus* sp.; Union Bay on V.I., Cultus Lake, and Shuswap Lake.

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**Acknowledgment**

The writers are indebted to D. Hardwick, Division of Entomology, Ottawa, for the identification of our *Plusia* **adults.**

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# CHEMICAL CONTROL OF THE BROWN MITE, *BRYOBIA ARBOREA* M. & A., AND OF THE CLOVER MITE, *B. PRAETIOSA* KOCH, IN BRITISH COLUMBIA[1]

R. S. Downing[2]

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The mite previously known as the clover mite, *Bryobia praetiosa* Koch, has recently been separated into two species. *Bryobia arborea* M. & A. and *B. praetiosa* Koch, and the common names, brown mite and clover mite, respectively, have been suggested (Morgan and Anderson, in press). Although the two mites are closely related, differences in their life-histories, as shown by Anderson and Morgan (in preparation), are important in determining chemical control procedures.

The brown mite is an orchard pest. Its life-history and feeding habits are similar to those of the European red mite, *Metatetranychus ulmi* (Koch), but, except for occasional outbreaks, it is not so important a pest. The clover mite, on the other hand, is not strictly an orchard pest. It feeds on a wide range of herbaceous plants, from which it often moves into dwellings; consequently it is better known as a household pest.

This report compares the chemical control of these two closely related mites.

## Chemical Control of the Brown Mite

At the pink bud stage of apple tree development the brown mite is in the larval or early nymphal stage and is particularly vulnerable to chemical control. It has been reported that the systemic preparations demeton (Systox, Geary Chemical Company, New York, N.Y.) and schradan (Pestox 3, Pest Control Limited, Cambridge, England) (Downing, 1953), and the sulpho esters fenson (Murvesco, Murphy Chemical Company, Wheathampstead, England) and ovex (Ovotran, Dow Chemical Company, Midland, Michigan) (Downing, in press), in pink bud applications have given excellent control of the brown mite for the whole season. Fenson and ovex, having lower mammalian toxicity than Systox and schradan, are the recommended materials in British Columbia.

The brown mite can also be controlled in the summer months (Downing, in press) but, owing to the presence of eggs as well as active mites, acaricides are less effective as summer applications than as pink bud applications.

## Chemical Control of the Clover Mite

The life-history of the clover mite is more complex than that of the brown mite. Although the former species overwinters mainly in the egg and adult stages, larvae and nymphs are sometimes present, too. Consequently chemical control cannot be directed against active stages alone, as with the brown mite. To be highly effective against the clover mite, an acaricide must be effective against eggs as well as active stages, or have a persistent residual effect.

Most of the chemical control experiments carried out against these mites in the interior of British Columbia were conducted around homes and in gardens. The acaricides were applied with a bucket pump sprayer to outside walls of homes, or to infested grasses and ornamental plants nearby. The abundance of mites was not estimated by sampling and counting; instead, it was approximated by general observation of treated areas before and after spraying.

Sulphur dust has been recommended in some areas for the control of the clover mite around homes (Zappe, 1939); but several householders in

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Summerland and Penticton claimed it was ineffective. An experiment was carried out by dusting wettable sulphur on the soil around the foundation of a home in May, 1955. Although the mites moved freely through the sulphur they survived with little or no sign of injury.

On another occasion malathion, a chemical recommended for control of the brown mite on fruit trees, was used by a householder to control the clover mite; he claimed poor results. A second experiment was undertaken, therefore, to determine the control of the clover mite by each of three acaricidal mixtures. The materials were applied as sprays to separate areas on the walls of the house, to the soil at the bases of the walls, and to plants in the garden. Malathion (25 per cent; Pennsylvania Salt Manufacturing Company, Tacoma, Washington) at two pounds per 100 gallons and wettable sulphur (92 per cent; Canadian Industries Limited, Montreal, Quebec) at two pounds were each ineffective. Kelthane (18.5 per cent 1, 1-bis (*p*-chlorophenyl) 2, 2, 2-trichloroethanol; Rohm and Haas Company, Philadelphia, Pennsylvania) at two pounds on the other hand, gave satisfactory control.

The following year, May, 1956, Kelthane (18.5 per cent) was compared in the laboratory and in the field with Sulphenone (Sulphenone 50-W, containing 40% *p*-chlorophenyl phenyl sulphone and 10% related diaryl sulphones; Stauffer Chemical Company, Mountain View, California). The latter is currently recommended in British Columbia for summer control of the brown mite on fruit trees. In the laboratory a sheet of filter paper was dipped in an aqueous acaricidal suspension and allowed to dry. Then the sheet was placed in the bottom of a quartsize frozen-food container into which about 30 mites were introduced. The mites were confined in the container for two days, after which living and dead mites were recorded. There were five replicates per treatment. Kelthane, two pounds per 100 gallons, allowed eight per cent survival; Sulphenone, four pounds allowed 31 per cent; in the untreated control, survival was 87 per cent.

The two acaricides were applied to separate areas on the outside walls of a house heavily infested with the clover mite, and to the soil at the bases of the walls and to the lawn for a distance of eight feet from the house. Kelthane, two pounds per 100 gallons, gave excellent initial and residual control of the mites; Sulphenone, although fairly effective, was obviously inferior.

## Summary

The brown mite, a species that attacks fruit trees, was satisfactorily controlled with a pre-bloom spray of fenson or ovex, or either of the systemic insecticides schradan and Systox. The clover mite, which occurs as a pest on grasses and a wide range of herbaceous plants and is a pest in and around homes, was controlled with one application of Kelthane. Sulphenone controlled the clover mite fairly well, but was not so effective as Kelthane, whereas malathion and wettable sulphur were unsatisfactory.

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# A HISTORY OF RECENT FOREST TENT CATERPILLAR INFESTATIONS IN THE INTERIOR OF BRITISH COLUMBIA

S. F. Condrashoff[2]

The forest tent caterpillar, *Malacosoma disstria* Hbn., (*M. erosa* (Stretch)), was recorded in the interior of British Columbia as early as 1906. In the past the species was known primarily as a pest of shade trees and shrubs in parks, resort areas, and about homes. Recently the insect has been considered important as a forest species and has received added attention from the Forest Insect Survey. The forest tent caterpillar is of interest in studies on population dynamics, natural control, and as a possible indicator species for predicting outbreaks of other forest insect species. Though severe infestations have resulted in complete defoliation tree mortality has not been recorded in British Columbia.

Earliest records of infestation found by the author dated to 1923 and 1924 as occurring in "Interior B.C.", and in the Revelstoke area. Infestations were recorded for the period 1934-1939 at Vernon, Salmon Arm, Kamloops, and "Interior B.C." For the period 1939-1946 records were more numerous, but unfortunately neither continuous nor complete.

Beginning in 1946 the Forest Insect Survey included *Malacosoma disstria* among the species to receive special attention, resulting in the accumulation of more reliable and continuous records on infestations.

In 1948 an infestation was found at Quesnel which continued during subsequent years. In 1950 infestations

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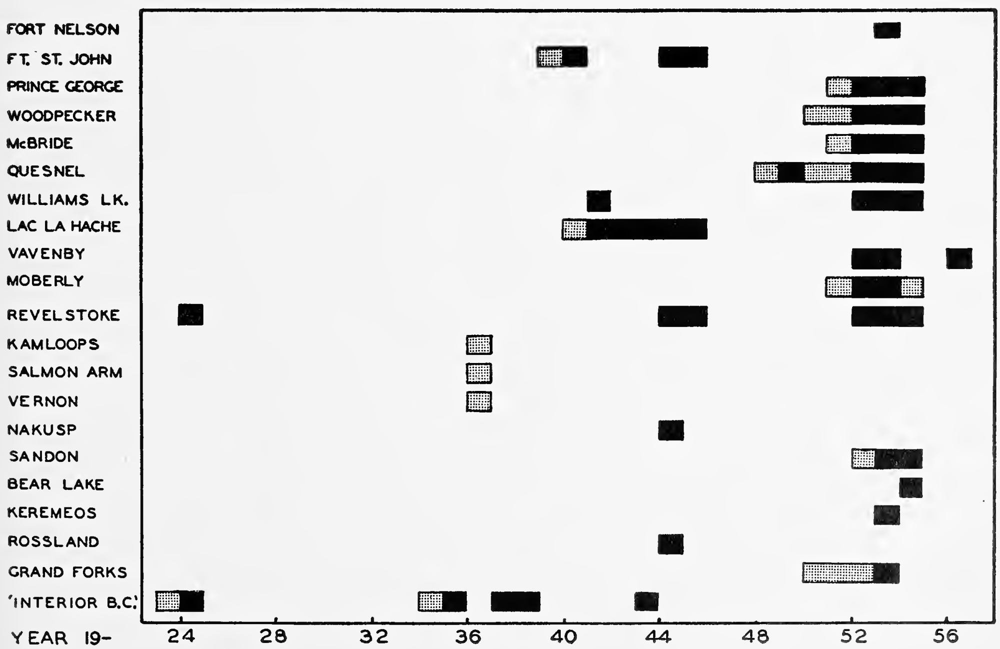


Fig. 1.—Records of occurrence of *Malacosoma disstria* infestations in interior British Columbia from 1923 to 1956. Dotted bars show medium infestation; black bars indicate heavy infestation.

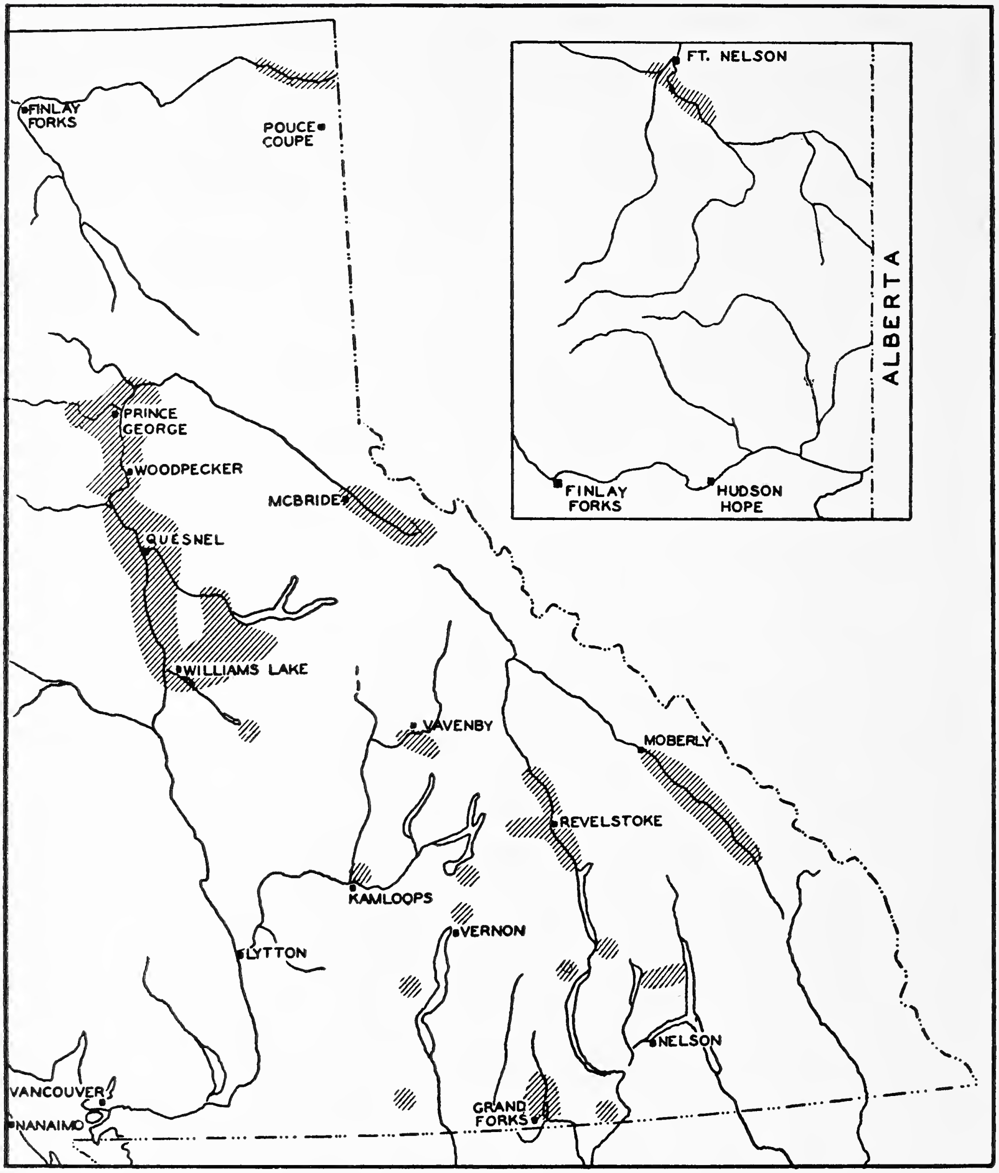


Fig. 2.—Distribution of *Malacosoma disstria* infestations in interior British Columbia, 1924-1956.

occurred at Woodpecker and Grand Forks. During 1951 and 1952 infestations began at Prince George, McBride to Swiftwater, Williams Lake, Vavenby, Moberly to Radium Junction, Revelstoke, and Sandon. By 1953 the caterpillar populations in these areas increased tremendously and spread; infestations at Woodpecker coalesced with those of Quesnel. In 1954 the infestations remained at a high level and continued to spread and coalesce so that a continuous line of infestation occurred from Salmon Valley north of Prince George, to Williams Lake; the Vavenby and Grand Forks infestations disappeared. Infestations were discovered at Fort Nelson and Keremeos in 1953 and at Bear Lake (near Kelowna) in 1954, but these subsided. In 1955 no infestations or traces of *M. disstria* were found except at Summit Lake near Nakusp where larvae were present until they succumbed to disease. Only a single infestation was discovered in 1956 near Vavenby in a previously inaccessible area (see Figures 1 and 2).

*M. disstria* populations undergo extreme fluctuations as is suggested by the chart in Fig. 1. Baird (1920) mentions that records (1790-1920) for *M. disstria* in North America indicate "years of abundance followed by years of scarcity".

It is difficult at this time to isolate factors responsible for past population collapses. Sufficient evidence is not available to determine the role of parasites in the past collapses. Observations in the field in some instances have shown that disease can be an important natural control factor.

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## PLANS TO ERADICATE ORIENTAL FRUIT MOTH IN THE OKANAGAN VALLEY, B.C.

W. D. TOUZEAU[1] and C. L. NEILSON[2]

In late September of 1956 cannery peaches in Summerland, B.C., were found to contain live insect larvae. These peaches had been imported from the Yakima area of Washington State, U.S.A. Specimens presented to Provincial and Federal authorities were subsequently identified by G. G. Dustan, Officer-in-Charge, Fruit Insect Laboratory, Vineland, Ontario, as oriental fruit moth, *Grapholitha molesta* (Busck.).

Infestations reported to be as high as 30% were noted in some boxes of fruit. Local cannery practices consisted of spreading cannery waste by manure spreader throughout an adjoining orchard. This was stopped and all future waste was buried in a pit. In view of the fact that little of the imported crop of peaches was left for processing, canning was allowed to continue, but all further importations of cannery fruit were prohibited. It would appear that the infestation occurred only in a small portion of the imports, as further examination failed to reveal any larvae.

Cannery boxes in which the shipments had been made were ordered returned to the U.S.A. There was some delay in action which finally took place on the threat of burning.

Import records at the Canadian Customs port of Osoyoos were reviewed. All loads of fruit received were covered by certificates indicating that adequate fumigation measures had been taken from the standpoint of temperature, time, and dosage. No explanation for the failure of fumigation has been provided.

Enquiries were made on the exact origin of the specific load of fruit first found to be heavily infested. The

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orchard from which this fruit originated was said to be in the fringe area of the known infested area in Yakima. This orchard had not been trapped but traps in adjoining orchards had caught no moths in the past two seasons. There had been no local reports of infested fruit from this orchard and the only possible sign of trouble might be associated with twig flagging, a symptom not unusual with twig borer damage.

It was learned that two canneries in the Okanagan, the York Cannery at Osoyoos and Barkwills at Summerland, had received fruit from the same area, Yakima, while a third cannery, Rowcliffe at Kelowna, had received peaches only from the Wenatchee area. The Osoyoos cannery had completed operations but the personnel had not seen any infested fruit. The Kelowna cannery was still in operation; a careful check of the stock on hand did not reveal any larvae. It was concluded that the Summerland area would have to be considered infested, as larvae had been found; the Osoyoos area possibly infested as peaches had been obtained from the same source; but the Kelowna area could be considered as not infested, as the fruit used was from another source and no infestation was found on investigation.

Federal and Provincial officials, alarmed at the finding of oriental fruit moth larvae in Summerland, decided that definite action must be taken in an endeavour to prevent this insect from becoming established in the Okanagan Valley. Consultations were held with U. S. authorities versed in oriental fruit moth and fumigation procedures. Canadian authorities concerned themselves with methods to be used in an attempt to eradicate this potential pest.

It was decided that before the 1957 growing season commenced the canneries at Osoyoos and Summerland would be completely covered with tarpaulins and fumigated with methyl bromide. The orchard adjacent to the Summerland property would be removed and burned and the land fumigated with methyl bromide. The same fumigant would be used on the fruit dump at Osoyoos and the hillside adjoining the cannery at Summerland. The ripening rooms of both canneries would receive a fall fumigation. Spring and summer spraying of host plants of the oriental fruit moth would be undertaken in the areas adjacent to the canneries, and compensation would be arranged for fruit unfit for human consumption due to excessive DDT residue. Insect traps would be placed on the fumigated buildings and in an area beyond a one-mile radius, as well as spot trapping from the Interna-Boundary to Summerland.

It is hoped that this combined Provincial-Federal action will forestall the establishment of oriental fruit moth in the Okanagan Valley. Should this insect become established and prove to be of economic importance, it could cost the tree fruit industry some $200,000.00 a year. An estimated investment of $65,000.00 attempting eradication was considered well worth while.

## Royal Jelly, the New Elixir

Last winter the School of Domestic Science asked me where a supply of royal jelly could be obtained. Apparently the School of Physical Education was seeking it to feed to the basketball team to enable them to win games. I applied to Hugh B. Leech of the California Academy of Sciences who sent me the addresses of two firms who supply royal jelly in retail or wholesale lots.

Fabulous claims are made for it. For a mere $60.00 you can obtain a month's supply to enable you to accomplish almost anything, physically or mentally. As might be expected, the amounts required for these miracles, are very small indeed. The latest use for it is in cosmetics; as a skin food, one application will remove wrinkles for 24 hours and for a mere $10.00 one can become young again.—*G. J. Spencer, Dept of Zoology, University of British Columbia.*

# SPECIES OF ROOT MAGGOTS (DIPTERA: ANTHOMYIIDAE) OF CRUCIFEROUS CROPS IN BRITISH COLUMBIA[1]

A. R. Forbes[2] and D. G. Finlayson[3]

Several species of root maggots occur separately or in mixed populations in cruciferous crops in Canada (Matthewman *et al.*, 1950, Brooks 1951, Oughton 1952, and Pond 1956). The composition of these populations varies seasonally and geographically, and, since each species differs in habits, life history, and economic significance it is important to know which ones occur on a crop.

When a primary, phytophagous species attacks a root, the damage frequently attracts phytosaprophagous species and, as decay progresses, additional saprophagous species, predators, and parasites are attracted to the root. A complicated ecological succession is started by the original attack, especially in rutabagas (swede turnips), which have a long growing period and large, fleshy roots.

These facts make analyses of field populations prerequisite to root maggot studies and particularly to control tests.

Root maggots were collected from cruciferous crops in British Columbia from 1948 to 1956. This paper reports data from these collections, with particular reference to *Hylemya* spp. in rutabagas.

## Methods

Single and periodic collections were made from various cruciferous crops at many localities throughout British Columbia. For rutabagas, several collections were made from the same fields during the growing season for four years at Courtenay, three years at Victoria, two years at Alberni, and one year at Tappen and Salmon Arm. The same farms at Courtenay, Victoria and Alberni were used each year. The maggots were generally collected from 30 roots taken at random from portions of the fields not treated with insecticide. The roots were carefully dissected and all maggots found were removed and preserved. The maggots were later identified with Brooks' key (Brooks 1951).

Larvae and puparia for rearing were collected from roots of cruciferous crops at Agassiz, Cloverdale, Kamloops, Kelowna, Ladner, Milner, Tappen and Victoria. The adults were identified by officers of the Entomology Division, Ottawa. Records of adults in the Canadian National Collection of Insects were also obtained.

One hundred and seven collections of maggots were made and identified from cultivated crucifers during the eight years 1949 - 1956 (Table I). Most of these were from rutabagas, but one or more collections were made from each of cabbage, radish, turnip, cauliflower and broccoli. The collections were from all the major agricultural areas in the Province except the Peace River area (Table II).

## Species Found

Larvae of four species of *Hylemya* were found: the cabbage maggot, *H. brassicae* (Bouché); the seed-corn maggot, *H. cilicrura* (Rond.); the turnip maggot, *H. floralis* (Fall.); and *H. fugax* (Meig.).

Of 395 flies of the genus *Hylemya* reared from larvae from cabbage, radish, rutabagas, and brussels sprouts from eight localities, 78 per cent were of *brassicae,* 17 per cent were of *cilicrura,* 5 per cent were of *fugax,* and 0.2 per cent were of *planipalpis* (Stein).

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Since larvae of *planipalpis* and *brassicae* cannot be separated satisfactorily by Brooks' key, a few of the larvae reported as of *brassicae* might be of *planipalpis*. Identifications of adults, however, showed that this error was very small. Similarly, a few of the larvae given as of *cilicrura* might be of *liturata* (Meig.) (=*trichodactyla* (Rond.)). No adults of *liturata* were reared from crucifers but the species was reared by Mr. J. H. McLeod, now of the Entomology Laboratory, Belleville, Ontario, from bean roots at Vancouver. It occurs elsewhere in Canada on cultivated crucifers.

The cabbage maggot is the most common and most widely distributed root maggot in British Columbia (Tables I and II). It was the most abundant species throughout the growing seasons (Table III) and constituted 82 per cent of the total *Hylemya* maggots collected. It is the most serious pest of cultivated crucifers in the province. Up to 90 per cent of the plants of untreated early stem brassica crops have been killed by the maggots (Kings *et al.* 1957), and approximately 80 per cent of untreated rutabagas are frequently rendered unmarketable because of maggot damage (King and Forbes 1954).

**TABLE I.—Numbers of larvae of various species of *Hylemya* collected from various cruciferous crops in British Columbia, 1949 - 1956.**

| Crop | Number of collections | *brassicae* | *cilicrura* | *floralis* | *fugax* | Total |
|---|---|---|---|---|---|---|
| Cabbage | 5 | 804 | 12 | 0 | 3 | 819 |
| Cauliflower | 2 | 78 | 1 | 0 | 0 | 79 |
| Broccoli | 1 | 0 | 1 | 23 | 0 | 24 |
| Radish | 4 | 185 | 4 | 0 | 0 | 189 |
| Rutabaga | 93 | 3190 | 761 | 140 | 3 | 4094 |
| Turnip | 2 | 39 | 0 | 0 | 0 | 39 |
| Total | 107 | 4296 | 779 | 163 | 6 | 5244 |
| % of grand total | — | 81.9 | 14.9 | 3.1 | 0.1 | — |

The seed-corn maggot is also generally distributed in British Columbia. It formed 2 per cent of the *Hylemya* larvae collected from cabbages and 18.6 per cent of those from rutabagas (Table I). It became increasingly common in rutabagas as the seasons progressed until it constituted about 20 per cent of the total maggots in the roots. The larvae always occurred in association with *brassicae* or *floralis* larvae, or both, so that there was no evidence that they caused primary root damage. In coastal British Columbia during backward spring weather, the seed-corn maggot is often a fairly serious pest on sprouting seeds, especially beans and peas.

The turnip maggot was collected from rutabagas at Courtenay, Prince George and Smithers and from broccoli at Prince George. Records of the adults include one as far north as Atlin. It is significant that in Alaska the turnip maggot is the most important and widely distributed root maggot whereas the cabbage maggot has not been recorded (Washburn 1953, p. 3). In British Columbia it was taken only during August and September (Table III). At Courtenay, where periodic collections were made from rutabagas, *floralis* occurred on the roots during August and early September each year, sometimes being more abundant than *brassicae*. In north-central British Columbia *floralis*

**TABLE II.—Localities in which larvae and adults of six species of *Hylemya* were found in British Columbia.**

| Species | Localities |
|---|---|
| *brassicae* (Bouché) | Larvae: Agassiz, Alberni, Armstrong, Barnhartvale, Cloverdale, Comox, Courtenay, Cranbrook, Creston, Grand Forks, Honeymoon Bay, Kamloops, Kelowna, Lavington, Ladner, Milner, Penticton, Quesnel, Smithers, Sullivan Station, Salmon Arm, Tappen, Thrums, Vancouver, Victoria. |
| | Adults: Agassiz, Armstrong, Cloverdale, Cultus Lake, Duncan, Essondale, Hazelton, Kamloops, Kelowna, Ladner, Milner, Pacific, Port Hammond, Robson, Saanich, Sicamous, Tappen, Vancouver, Vernon, Victoria. |
| *cilicrura* (Rond.) | Larvae: Alberni, Cloverdale, Comox, Courtenay, Grand Forks, Honeymoon Bay, Kamloops, Kelowna, Ladner, Prince George, Quesnel, Salmon Arm, Sullivan Station, Tappen, Victoria. |
| | Adults: Agassiz, Cloverdale, Cultus Lake, Hedley, Kelowna, Keremeos, Ladner, Milner, Naramata, Nicola, Oliver, Robson, Salmon Arm, Summerland, Tappen, Vancouver, Vernon, Victoria. |
| *floralis* (Fall.) | Larvae: Courtenay Prince George, Smithers. |
| | Adults: Armstrong, Atlin, Invermere. |
| *fugax* (Meig.) | Larvae: Armstrong, Quesnel, Victoria. |
| | Adults: Agassiz, Kamloops, Robson, Cultus Lake. |
| *planipalpis* (Stein) | Adults: Milner, Victoria. |
| *liturata* (Meig.) | Adult: Vancouver. |

caused severe damage to rutabagas and broccoli in August, 1954.

The maggot *H. fugax* constituted only 0.1 per cent of the *Hylemya* larvae collected. It occurred in cabbage at Quesnel and in rutabagas at Armstrong and Victoria. Adults were reared from maggots from brussels sprouts at Agassiz and from radish at Kamloops.

A single fly of *H. planipalpis* was reared from a maggot collected from rutabaga at Milner in 1950. An adult of this species was taken at Victoria on July 2, 1918, by Mr. W. Downes, formerly of the Fruit Insect Laboratory, Victoria, British Columbia. It is a major pest of radish in the Prairie Provinces (Brooks 1951).

**TABLE III.—Numbers of *Hylemya* larvae collected from cruciferous crops in British Columbia, by months, 1949 - 1956.**

| Species | June | July | August | September | October | November |
|---|---|---|---|---|---|---|
| *brassicae* (Bouché) | 806 | 422 | 873 | 784 | 1331 | 80 |
| *cilicrura* (Rond.) | 16 | 42 | 262 | 195 | 263 | 1 |
| *floralis* (Fall.) | | | 138 | 25 | | |
| *fugax* (Meig.) | | | | | 6 | |
| Total | 822 | 464 | 1273 | 1004 | 1600 | 81 |

Other maggots collected in small numbers from roots of rutabagas included: *Dolichopus* sp., *Fannia canicularis* (L.), *Lonchaea vaginalis* Fall., *Muscina assimilis* (Fall.), *Oscinella* sp. (coxendix group), *Eumerus strigatus* (Fall.), *Sciara* sp., and a phorid. The maggots *Fannia canicularis* and *Muscina assimilis* were very common on roots of cabbages infected with clubroot that had begun to decay.

Adults of *Coenosia tigrina* (Fall.), a dipterous predator first reported in Canada from Quebec (Perron and Lafrance 1952), were reared from immature stages from rutabagas at Tappen, B.C., in 1950.

## Summary

Root maggots collected during 8 years from cruciferous crops in British Columbia were mostly the cabbage maggot, *Hylemya brassicae* (Bouché). The seed-corn maggot, *H. cilicrura* (Rond.) occurred frequently and the turnip maggot, *H. floralis* (Fall.) was found only during August and September at Courtenay, Prince George and Smithers. *H. fugax* (Meig.) was collected in small numbers. A single adult of *H. planipalpis* (Stein) was reared from a maggot collected from rutabaga at Milner. *H. liturata* (Meig.) was not found in crucifers, but did occur in bean roots at Vancouver. *H. brassicae* and *H. floralis* caused primary root damage. On rutabagas, *H. cilicrura* occurred only in association with *brassicae* or *floralis*, or both.

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# ON THE ACRIDIOPHAGOUS SARCOPHAGIDAE OF BRITISH COLUMBIA WITH RECORDS OF ALL OTHERS TAKEN IN THE PROVINCE

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## Introduction

In 1934 Howard Curran (4) proposed the name Metopiidae, to include in the family "all the flies previously known as Sarcophagidae, part of the Muscidae and part of the Tachinidae of Williston's Manual, which is apparently a natural association as proved by a study of larval and pupal characters."

The larvae of the Metopiidae are either scavengers or flesh feeders, parasitic chiefly on invertebrates, especially insects. A few are sometimes myiasis-producers on vertebrates. Apparently all the members of the old family Sarcophagidae are larviparous but within the family Metopiidae as now constituted, there is, even in this Province, a nice gradation in methods of reproduction from truly larviparous flies to those that lay eggs which hatch almost the instant they are extruded, others the eggs of which hatch within 10 seconds or so, and yet others the eggs of which may require as long as 24 hours to hatch. All the maggots of the Sarcophagidae *sens. strict.* have the posterior spiracles situated within a deep depression. For the most part, the flies have two silvery-grey stripes and three black stripes on the thorax and have tesselated abdomens; the antennal arista is plumose above and below for only half of its length, and the vein $M_1$ bends strongly forward towards $R_5$, although the apical cell is almost always open.

The classification of the Metopiidae, as Curran says, is in a chaotic condition because "a great many genera have been proposed upon characters possessed by one sex or the other and upon characters which are apparently of not more than specific or group value, which are found to be entirely unsatisfactory when large collections are studied." Townsend especially has produced a bewildering array of generic names: in the 54 species with which we are concerned in this paper, he has proposed 16 new genera — all ignored by Curran (4), and Brues, Melander and Carpenter (2). Curran's family Metopiidae now includes such well-known but diverse forms as the common blue and green blowflies, the black blowflies that attack sheep, those that parasitize nestling birds, the cluster fly that attacks earthworms, and the true Sarcophagidae. For the sake of simplicity we are using here the nomenclature of Aldrich (1) with a few more recent changes but indicating in brackets Townsend's generic grouping and nomenclature.

The habits of attack of these Sarcophagidae vary from those of *Wohlfahrtia vigil* and *W. meigenii* (*Paraphyto opaca*) which larviposit on the very young of wild and caged mammals such as mink, and sometimes on babies; *Sarcophaga citellivora* which attacks ground squirrels; *S. magna* which attacks the western striped June beetle *Polyphylla perversa; S. eleodis* which attacks the large black darkling beetles; *Agria affinis* and *S. tuberosa sarracenioides* which parasitize caterpillars of butterflies and moths, including the spruce budworm; to *S. l'herminieri* which develops in carrion and dung, chiefly cow manure, the commonest and most widespread species in this Province and most of the northern part of the continent (1).

This paper is based on British Columbia records of Sarcophagidae from the Canadian National Collection at Ottawa, the collections at the University in Vancouver, the Dominion Entomological Laboratory at Kamloops, and from literature (3) (5) (7).

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The field observations, rearing experiments, identifications, records of distribution and writing of this paper, were done by G. J. Spencer, and the mass cage rearing, making of the Kamloops collection and preliminary lists of Sarcophagidae, by E. R. Buckell (3).

Some of this material was presented in a paper entitled: "The natural control complex affecting grasshoppers in the dry belt of British Columbia", to the 10th International Congress of Entomology, at Montreal, August 1956.

## BRITISH COLUMBIA RECORDS OF SARCOPHAGIDAE TO APRIL 1957

*Emblemasoma erro* Ald.

*Wohlfahrtia vigil* Walk. Iden. H. J. Reinhard. Quesnel. Rare.

*Paraphyto opaca* Coq. (*W. meigenii* Schiner). Nicola, Kamloops, Vernon, Chilliwack, Vancouver.

*Brachycoma devia* Fall.

*B. sarcophagina* Towns.

*Agria* (*Pseudosarcophaga* Kramer) *affinis* Fall. Monashee, Robson, Salmon Arm, Lumby, Vancouver.

*Sarcofahrtia ravinia* Park. (*Thelodiscus indivisus* Ald.) Chase. Rare.

*Senotainia flavicornis* Towns. Chase, Kamloops. Rare.

*Blaesoxiphotheca* (*Sarcophaga* Meig.) *coloradensis* Ald. Common at Kamloops in 1954 when most other species were absent; Chilcotin.

*B. caudata* Towns. Females abundant at Lytton in 1931 "not referable to species without males" (D. G. Hall).

*Acanthodotheca* Towns. 2 spp. undet. of this genus from B.C. in C.N.C.

*Helicobia rapax* Walk. (*Sarcophaga helicis* Towns. Ald.) The prevailing fly attacking *M. bilituratus* at Lytton in 1931; one of the earliest sarcophagids of the season. Nicola, Kamloops, Lytton, Robson. Reared also from the longicorn *Ergates spiculatus* Lec. at Kamloops.

*Metoposarcophaga importuna* Walk.

*Ravinia pusiola* (Van der Wulp). Robson.

*R. stimulans* (Walk.) (*quadrisetosa* Coq.). Robson.

*Sarcophaga* (*Sarcotachinella* Towns.) *sinuata* Meig. Lytton, Kamloops, Robson, Skidegate.

*S.* (*Boettcheria* Park.) *latisterna* Park. Vancouver.

*S.* (*Boettcheria* Park.) *cimbicis* Towns. Quesnel, Kamloops.

*S.* (*Boettcheria* Park.) n. sp. near *latisterna* (Det. Curran) in C.N.C. Seven places in B.C.

*S.* (*Fletcherimyia* Towns.) *fletcheri* Ald. Robson.

*S.* (*Tephromyiella* Towns.) *atlanis* Ald. Kamloops, Stump Lake, Nicola, Robson.

*S.* (*Protodexia* Towns.) *hunteri* Hough. The prevailing gropper parasite in 1954 at Kamloops; Lytton, Robson.

*S.* (*Stenaulacotheca* Town.) *spatulata* Ald.

*S.* (*Opsophyto* Towns.) *opifera* Coq. The most abundant sarcophagid in the dry belt; Kamloops, Nicola, Chase, Vernon, Lytton.

*S.* (*Eleodiomyia* Towns.) *eleodis* Ald. Kamloops, Robson.

*S.* (*Kellymyia* Towns.) *kellyi* Ald. Irregular in occurrence but abundant when present. Lytton, Kamloops, Kelowna, Nicola, Robson.

*S.* (*Zygastropyga* Towns.) *sulculata* Ald. Vancouver, Kamloops. Very rare.

*S.* (*Bercaeopsis* Towns.) *wrangeliensis* Park.

*S.* (*Bercaeopsis* Towns.) *vancouverensis* Park.

*S.* (*Acridiophaga* Towns.) *setigera* Ald. B.C.-Alberta boundary.

*S.* (*Acridiophaga* Towns.) *falciformis* Ald. Kamloops, Robson.

*S.* (*Acridiophaga* Towns.) *savoryi* Park.

*S.* (*Acridiophaga* Towns.) *aspertella* Park.

*S.* (*Acridiophaga* Towns.) (*Metoposarcophaga*) *tothilli* Park.

*S.* (*Metoposarcophaga*) *incurva* Ald. Robson.

*S.* (*Robineauella* End.) *juliaetta* Ald. Shuswap Narrows. Very rare.

*S.* (*Robineauella* End.) *occidentalis* Ald. Vancouver. Rare.

*S.* (*Robineauella* End.) *tuberosa* var. *exuberans* Pand. Nicola, Kamloops, Robson. Uncommon.

*S.* (*Robineauella* End.) *tuberosa* var. *sarracenioides* Ald. Lytton, Kamloops.

*S.* (*Robineauella* End.) *tuberosa* var. *harpax* Pand. Lytton, Nicola, Kamloops, Hat Creek, Chilcotin, Alexandria. Common.

*S.* (*Robineauella* End.) *nearctica* Park. (*scoparia* Pand.). Vancouver, Kamloops, Robson. Scarce.

*S.* (*Robineauella* End.) *bullata* Park. Kamloops, Vancouver.

*S.* (*Robineauella* End.) *cooleyi* Park. Chilcotin, Robson. Very rare.

*S. plinthopyga* wiedmann (*robusta* Ald.). Reared in Vancouver from mammal skulls sent from Mexico. There is a specimen from Seattle in U.S.N.M. (Aldrich) so it may occur naturally in B.C. also.

*S. insurgens* Ald. Kamloops, Chase. Scarce.

*S. magna* Ald.

*S. haemorrhoidalis* Fall. Vancouver. Rare.

*S. thatuna* Ald. Nanaimo. Rare.

*S.* (*Miltoravinia* Towns.) *planifrons* Ald. Kamloops, Nicola.

*S.* (*Euravinia* Towns.) *l'herminieri* Robineau-Desvoidy. Widespread and common; Kamloops, Nicola, Robson, Cariboo, Vancouver.

*S.* (*Chaetoravinia* Towns) *latisetosa* Park.

*S.* (*Acridiophaga* Towns.) *reversa* Ald. Very common at Kamloops, merely occurs in the Nicola.

*S.* (*Acridiophaga* Towns.) *uncata* Van der Wulp (*marginata* Ald.) Kamloops. Rare.

*S.* (*Acridiophaga* Towns.) *caridei* Brethés (*angustifrons* Ald.). Kamloops. Rare.

*S.* (*Acridiophaga* Towns.) *aculeata* Ald. Lytton, Kamloops. Scarce.

*S.* (*Acridiophaga* Towns.) *aculeata* var. *taediosa* Ald. The prevailing variety of *aculeata* in B.C. Kamloops.

*S.* (*Acridiophaga* Towns.) *aculeata* var. *gavia* Ald. Kamloops. Rare.

*S.* (*Acridiophaga* Towns.) *aculeata* var. unplaced because no males; very many females; Kamloops, Pritchard, Trap Lake, Midway.

Of these 54 identified species, all but the following 13 in the Canadian National Collection are represented in the collections at the University of British Columbia. Most of the University specimens were collected by G. J. Spencer: *Sarcophaga aspertella, Brachycoma devia, Blaesoxiphotheca caudata, Emblemasoma erro, Metoposarcophaga importuna, S. magna, S. occidentalis, Ravinia pusiola, Brachycoma sarcophagina, S. savoryi, S. tothilli, S. vancouverensis, S. wrageliensis.*

## Biology

In connection with the grasshopper parasites some terms should be defined. A grasshopper is a member of the family Acridiidae, or short-horned, jumping Orthoptera; a hopper is the flightless nymph of a grasshopper; a locust is a short-horned grasshopper which regularly, or irregularly, congregates and migrates in a swarm (8). To indicate an orthopteroid population of any combination of flying adults and flightless nymphs of several to many species, I propose, and will employ the term "gropper". There are no true locusts in this Province in normal years, but one species, *Melanoplus bilituratus* (Walker), hitherto (6) called *Melanoplus mexicanus mexicanus* (Saussure), remains a localized grasshopper for 7 to 9 years and then increases to outbreak proportions. At such times the species may undertake locust-like mass flights for short distances, or for several to many miles. Apparently *M. bilituratus* is closely related to *M. spretus* Walsh, the notorious Rocky Mountain locust, a long-winged race which arose on the eastern slopes of the Rockies and migrated eastwards as far as the valley of the Mississippi from 1868 to about 1870. *M. bilituratus* is widespread in B.C., but becomes a serious pest periodically and only in the dry belt (7).

Another even more widespread acridiid is *Camnula pellucida* Scudder, the roadside grasshopper, which also develops to outbreak proportions but never becomes a locust, although it may scatter for wide distances from its developmental centres (7).

Practically all our parasite work has concerned these two species, especially the relationship of the sarcophagids to *M. bilituratus.* Of the 54 species of flies listed, the developmental habits of 27 are unknown, 14 have been bred from groppers at Lytton or Kamloops, and two species recorded elsewhere in North America as gropper parasites have been captured by us locally but not reared. One of the latter pair, *Acridiophaga caridei* is of particular interest. It is generally present in Argentina and Uruguay as a parasite of the gregarious locust *Schistocerca paranensis* Burmeister. From both these countries collections of larvae have been made by British workers and sent for colonization to the parasite laboratory at Belleville, Ontario. Canadian workers have reported that this is a very active and agressive fly, most suitable for building up populations under laboratory conditions. Many specimens have been liberated in Ontario. As far as our experts can tell, the identical species is found in this Province. We have captured a few specimens in the field near Kamloops but have never recovered *A. caridei* from the many thousands of groppers we have caged.

The 14 species or varieties which we have reared from groppers captured alive in the field and maintained in large rearing cages for parasite recovery, are: — *Blaesoxiphotheca coloradensis, Helicobia rapax, Sarcophaga sinuata, S. aculeata, S. aculeata* var. *gavia, S. aculeata,* var. indeterminable, *S. falciformis, S. reversa, S. kellyi, S. tuberosa* var. *exuberans, S. tuberosa* var. *sarracenioides, S. tuberosa* var. *harpax, S. opifera, S. hunteri.*

On the hills of the dry belt, 16 species including these 14, may be found in some seasons. All of them have certain habits in common as we have determined repeatedly by experiments conducted from 1931 to 1946 and in 1954. The flies occur unpredictably, abundant one day and absent the next, turning up suddenly in an area where they have never been taken previously, occurring in countless thousands in an area in the autumn and absent next spring; literally, they occur where you happen to find them.

Speaking of the 14 acridiophagous species as a group, the following summarizes the habits that these flies have in common:

1. Groppers in the dry belt of Brittish Columbia follow a fairly regular 7- to 9-year cycle of abundance and recession. In any area subject to attack by *M. bilituratus,* unless the cycle has been upset by control measures, the course of the cycle can be determined by the presence or absence of parasitic flies, and by comparing the relative numbers of hosts and parasites. An infestation with few or no associated parasites, is on the increase, and where parasites are abundant the host is in peak numbers, probably near the top of the curve or cycle, or just past it. By actual count, the proportion of flies to groppers may be 77 to 100, and in damp, grassy hollows, there may be more flies than groppers. Where this happens, in the next season the gropper population falls like a plummet.

2. All the species of sarcophagid flies concentrate upon *M. bilituratus,* our most agile, aggressive, harmful, and widely distributed gropper. There may be a dozen species of groppers present including a vast number of *pellucida,* but the highest sarcophagid parasitism obtained to date in *Camnula* has been only 6 per cent, and minor species may be unparasitized; *M. bilituratus* bears the brunt of the attack.

3. Nineteen species of sarcophagids have been experimented with on gropper-infested areas, 5 species not being parasites, and in *all* of them there exists an impulse activated apparently by visual stimulus, to pursue a small moving object. This was first determined in 1931 when the flies darted at inch-long pieces of alfalfa stems flicked with thumb and finger over them. Later on bits of wood the size of a gropper body were used but it was soon discovered that such shape and size were not essential in evoking the impulse; the flies would pursue small pebbles or even rolled-up pieces of paper. The impulse occurs in both sexes, but in the case of males, it is probably a sex urge for in the early part of the season when male flies only are present in an area, they will dart at everything within their range of vision.

4. The flies sit on objects just above the general ground level, such as stones or lumps of cattle and horse manure, and from these vantage points pursue groppers that jump or fly from near them. They strike the groppers from above, seemingly at the junction of thorax and abdomen between the wings, and return to the perching place. Given an even distribution of groppers, a field of stones suitable for perching places will have more flies in it than a grassy field without stones; a calm area will contain more flies than a windswept one, and the ultimate parasitism in a hollow will be much higher than in a windswept area.

In a stoneless area of short grass, infested with groppers and with considerable numbers of flies, three types of perches were tested: very dark, old burlap sacks; clean, light brown burlap sacks; and white flour sacks. These were spread at uniform distances over the sod. In a very few minutes the flies averaged 0.1 on the dirty old sacks, 4 on the clean brown sacks, and 10 or 12, and up to 20 on the white flour sacks. From these vantage points the flies pursued passing groppers, returning to the sacks after each trip.

Anything which disturbs groppers in an area causing them to leave the ground, results in increased parasitism. Domestic animals, especially grazing sheep, cause groppers to jump or fly and the sarcophagids then parasitize them. No instance has been noted of any of these 14 species of flies larvipositing on a gropper on the ground; the host must be either jumping in the case of a nymph, or flying. During one season, in the heat of the day when groppers normally do not fly, with *pellucida* groppers present in large numbers and flies of the *aculeata* complex abundant, the flies persistently bullied and buzzed at the groppers on the ground until they were forced to fly to escape the bullying, whereupon the flies struck at them. This harassment occurred for some time that year but has never been seen since.

5. The urge to chase a moving object results in female flies impartially pursuing *all* species of groppers in an area, both large nymphs of the 4th and 5th instars and adults, whenever these occur together.

6. As far as the human eye can perceive, there is physical contact between fly and gropper and *presumably,* a living larva is deposited. This seems to occur even when a small stick is flicked over a fly watching from its perch. But flies learn fast; if a succession of sticks is flicked over with a noticeable pause between each one, the first piece is apparently hit; the second time the fly stops a few inches short of it; the third time the fly may be 2 or 3 feet short of it, or merely fly a few feet off the perch, and back again.

Certain questions arise here: Does a fly deposit a maggot every time it strikes a gropper? Since flies appear to strike groppers indiscriminately, why is *M. bilituratus* alone so heavily parasitized? Conversely, why is *C. pellucida* apparently and markedly, almost immune from these flies?

To answer the first question, flies were collected just after they had pursued and apparently "struck" a gropper. Careful examination led to several conclusions: In the early part of the season and sometimes later, the fly was a male. Sometimes the gonads of the fly were immature, indicating that the pursuing impulse was not the result of a hormone secreted only at reproductive maturity. Sometimes the reproductive system was mature with a maggot ready in the common oviduct like a torpedo in a tube; apparently the fly had struck without discharging the maggot. This happened not infrequently when groppers were very active and when flies struck repeatedly. Presumably the flies had not time to discharge their maggots before the visual impulse impelled them to attack again. Sometimes when the reproductive system was mature, the common oviduct was empty, indicating that the maggot had just been discharged. This condition occurred many times when flies were active in a swarm of groppers. The visual impulse to strike had occurred before the next maggot was in place ready for discharge. It was not possible to determine exactly how fast and at what intervals a fly could discharge a succession of maggots. Even when a fly had discharged all its maggots, sometimes it apparently followed the impulse to strike until it died. The supply that a gravid and really fat fly (*aculeata* complex) had on hand, was 120 maggots, 60 in each ovary, all the maggots of uniform and apparently mature development.

To further check this question, groppers were collected and examined immediately after being struck by flies. This was done many times but never was a maggot found *on* a gropper's body and, to judge from experiments reported here, it was unlikely that the maggot had penetrated in the few seconds it took to collect the struck gropper. Unfortunately, the surface of the fan-like meta wings was not examined; it is possible that the maggots were deposited on the wings and left to penetrate the groppers later.

To answer the questions as to why *M. bilituratus* is particularly susceptible to attack by species of sarcophagids, and *C. pellucida* practically immune, both species of groppers were watched under attack in the field and laboratory, and experimentally struck to see if and how the maggots penetrated.

In the field, the behaviour of both *M. bilituratus* and *C. pellucida* differs according to the pressure of population, and the presence or absence of temporary migratory impulses. In dense populations there is, almost daily, a heavy local migration between feeding points. Groppers are freely attacked by flies as they get up from the ground, and sometimes the flies actually travel along with swarms out of which they have been captured by net. Under these conditions of seething populations, groppers do not seem to notice the flies at all, although the latter strike them freely.

In populations near the bottom of a cyclic curve, when groppers and flies may still be fairly numerous, both *M. bilituratus* and *C. pellucida* generally cut short their flight when struck, and pitch down, or nose-dive to the ground, and then assiduously clean their bodies as if in a conscious effort to free themselves of maggots. In the process the body is scraped with all the legs as thoroughly as a bee cleans herself, and the wings are opened and closed rapidly and then held aloft while fully open and rubbed down with the hind legs. The chances of a delicate maggot surviving such brushing seem remote. This behaviour on the part of struck groppers would tend to allow the establishment of more maggots in peak years when groppers do not pitch down and clean themselves, and fewer maggots during low populations near the bottom of the cycle when groppers take time to groom themselves.

In the laboratory, specimens of both species were immoblized, and first instar maggots were placed on their bodies. The procedure was as follows: flies were swept from vegetation in the field, treated with just enough chloroform, ether, or cyanide, to cause them to lose their balance and fall over. The abdomens of heavily gravid ones were then gently pressed with forceps and the fully formed maggots squeezed out. Sometimes pressure was not necessary and the maggots streamed out themselves. (There is a fine point at which it is possible to kill the flies and still have living maggots emerge. Once, a number of *S. kellyi* taken for pinning were cyanided and kept overnight in a salve box; next morning many small maggots were active in the box; they had consumed the contents of their mothers' bodies leaving only the body walls. When given a succession of freshly beheaded grasshoppers, they fed on these, reached maturity, pupated and emerged as flies.) When enough maggots were pressed out of a fly, they were held on a microscope slide until required, in a large drop of human saliva, which has been found a better medium than water or normal saline. Test groppers from an area of little or no parasitism were then immobilized in a row on a strip of wood by thin strips of scotch tape or adhesive, leaving exposed and readily accessible the particular portion of body needed. A maggot was picked up with the tip of a needle, or a very fine camel's hair brush wetted to a point, and placed on a selected part of the captive gropper.

Maggots of several species, chiefly *S. aculeata, S. reversa, S. kellyi,* the *S. tuberosa* trinity, *S. opifera* and *S. l'herminieri,* were placed on gropper bodies in various locations from the cervix to the anus, but not once was a maggot of any species observed to penetrate the inter-segmental membrane. The maggots were placed with only the viscous fluid from the parents' glands or without any fluid at all, or in drops of water or saliva, but none succeeded in penetrating the integument, or the spiracles, although all made drilling movements with their minute mouth-hooks.

Only one spot on the gropper's body was readily and easily penetrated by 1st instar larvae, and that was the tympanum or auditory organ on the first abdominal segment. Most tiny maggots penetrated it in from 10 to 30 seconds, generally nearer 10 seconds. This occurred either when the maggot was placed directly on the tympanum or when it happened to cross the tympanum in the course of its wanderings. The maggot always quickly disappeared from view, the gropper seemed none the worse for the incision, and the parasite developed normally.

Many maggots have been introduced into gropper bodies by making minute incisions with sharp dissecting needles or minute scalpels, and placing the larvae in the small drops of blood which welled up from the wounds. The blood had a stimulating effect on maggots; they increased the activity of their mouth hooks and very quickly penetrated the wound. Maggots were inserted into a gropper by placing them on the stump of a freshly severed leg; but in most cases after the amputations the groppers died within a few days. Once an even hundred *S. reversa* larvae were readily introduced into 100 *C. pellucida* through abdominal incisions, but no maggots became established. Perhaps the blood of *C. pellucida* itself was hostile to the maggots, although the maggots entered the incisions readily enough. The wounds were of secondary importance to the host.

The maggots of one species of fly, *S. l'herminieri* were repelled by the blood of a gropper into which they were actually shoved several times. Even when they were inserted directly into the gropper's body cavity they quickly came out again. Finally, when placed on fresh rabbit intestines they completed their growth and emerged as adults.

Another question arises: "Do maggots kill their hosts, and if so, how?" It has been noted in many places on the dry belt ranges that, in restricted areas, flies have been so numerous as apparently to outnumber their hosts; on the face of it, it would appear that not one gropper would reach the end of the season. The only certain way of determining parasitism is to dissect the host; but dissection kills the host and, unless it is full grown, the maggot also dies. Moreover, maggots of the smaller species of flies such as *H. rapax* and *S. opifera,* may occur two and three, or as many as nine to a gropper. Maggots of larger flies need one gropper apiece for their development.

If one maggot of a small fly like *S. opifera* should occur in a large, fat female *C. pellucida,* it does not necessarily kill the host. On one occasion a *Camnula* was watched while she laid an egg pod; immediately after a maggot emerged from her abdomen while the gropper hopped normally away. The fly was reared and turned out to be *S. opifera.*

We have seen that the hazards the tiny sarcophagid maggots have to pass before they can enter a gropper are considerable. Granted that one has safely entered a host — what happens? To answer this question, a long series of groppers were dissected and records kept of the condition of their body contents. For most of its growth period a larva apparently feeds on blood alone, then the fat body diminishes first through being starved, and later, apparently, by being consumed. In some cases the fat body remains intact but as a starved, thin membrane, and in this condition it is easily overlooked. Also at first examination, it would appear that the female reproductive organs are consumed, but again, careful examination shows them, apparently undeveloped and juvenile, but in reality, starved in a bloodless body cavity almost to the point of absorption. The ovarioles are present, but so small as to be easily overlooked. Often at this stage, the maggot emerges from the bloodless host, which soon succumbs. The maggots of larger flies, however, such as the *Blaesoxiphotheca* and *S. tuberosa* groups, requare the entire contents of the hosts, and when they emerge, the bodies of the hoppers are mere shells, and one can literally whistle through them.

Apart from the academic interest of this whole problem which has been condensed here almost to the point of detached statements, the practical application of the matter lies in these questions: If these Sarcophagid flies kill groppers readily and *sufficiently* to prevent cyclic increase, can the flies be reared in a parasite laboratory, kept in cold storage, and liberated where necessary to control a similar outbreak? Can we utilize them in the same way as some hymenopterous parasites are utilized?

Omitting the details of other experiments we can conclude: Of the groppers in British Columbia subject to periodic, cyclic increase, *M. bilituratus* is the only species which is very heavily attacked by 14 species of sarcophagids. Of these 14 species of flies, *S. kellyi* alone can be reared to maturity from expressed first instar maggots on a succession of immobolized or partly crushed groppers. The maggots can be fed fresh, beheaded hopper bodies daily or every other day, will readily complete their growth as maggots and will pupate; the pupae can be stored over winter. This is virtually a saprophagous trait as Mr. R. W. Smith found in the parasite laboratory in Belleville, Ontario, (personal communication) and yet in British Columbia, *S. kellyi* has sometimes proved a most aggressive and successful field parasite against outbreaks of *M. bilituratus*.

**Acknowledgments**

For records from the Canadian National Collection we are indebted to Mr. G. E. Shewell, Division of Entomology, Ottawa, who transcribed them and sent us the Townsend nomenclature. Mr. A. R. Brooks of the Entomological Laboratory at Saskatoon checked some identifications, and Dr. D. G. Hall, formerly of the U. S. National Museum, named the flies reared from grasshoppers at Lytton in 1931. To these specialists we extend our cordial thanks. We are grateful to Dr. R. H. Handford in charge of the laboratory at Kamloops, and to Dr. A. P. Arnason, Chief of the Crop Insect Unit at Ottawa, for permission to publish the sections of these records obtained during studies on the grasshoppers of this Province and finally, to the University of British Columbia which made a research grant to the senior author to enable him to continue the work at Kamloops in 1954.

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# A BRIEF HISTORY OF OUTBREAKS OF THE DOUGLAS-FIR TUSSOCK MOTH, *HEMEROCAMPA PSEUDOTSUGATA* McD., IN BRITISH COLUMBIA[1]

B. A. Sugden[2]

The Douglas-fir tussock moth was first reported defoliating Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco, near Chase in 1916. In 1921 the type specimens were obtained from this locality and described by McDunnough as a new species, *Hemerocampa pseudotsugata.* Prior to this the species was referred to as *Hemerocampa vetusta* form *gulosa* Hy. Edw. Since 1916 outbreaks have recurred at intervals in British Columbia, usually in semi-arid Douglas fir or Douglas-fir — ponderosa-pine forests. Severe infestation has resulted in top killing or complete tree mortality. The following notes on outbreaks of Douglas-fir tussock moth were compiled from the files of the Forest Biology Laboratory at Vernon.

## HISTORY OF OUTBREAKS

1916—The Douglas-fir tussock moth was causing some damage to Douglas fir growing in and near Chase[3].

1917—A small but severe infestation occurred at Hedley. The tussock moth continused to kill Douglas fir and some ponderosa pine trees in the vicinity of Chase[3].

1918—The Douglas-fir tussock moth remained active near Chase and Hedley; also minor outbreaks were reported at Salmon Arm and Armstrong.

1919—Infestations continued at Chase and Armstrong with new outbreaks at Vernon and Kamloops. Defoliation of Douglas fir was severe; the ponderosa pine foliage was damaged where the preferred host, fir, had been completely defoliated.

1920—The insect remained active between Vernon and Kelowna and in the marginal fir stands in the vicinity of Kamloops. A population decline occurred in the other infestations.

1921—Infestations remained active from Chase west to Kamloops and from Vernon south to Kelowna. Entirely defoliated trees had died; reproduction, saplings, and pole-sized Douglas fir trees suffered the highest mortality. Heavy defoliation of the mature or semi-mature fir often resulted in the death of the upper third of the crown.

1922—A large population hatched in the spring, but the larvae died before maturing, thus bringing the infestation to an abrupt end.

1928—No further activity was described until 1928 when two infestations developed, one near Kamloops and the other near Vernon. These outbreaks were in Douglas fir growing adjacent to ranch buildings.

1929—Outbreaks were reported from Chase, Little Shuswap Lake, Cascade, and Kettle Valley districts. Greatest damage occurred in Sullivan Valley where young Douglas fir and ponderosa pine trees on 100 acres were killed.

1930—The Douglas-fir tussock moth outbreaks remained active. They ranged in size from less than an acre to 1,000 acres. Reports indicated that there was damage near Chase, Grand Forks, Kettle Valley, south from Adams Lake to Squilax, between Haywood's Corner and Deep Creek, North Thompson Valley in the vicinity of McLure and Sullivan Creek, along Paul Lake road bordering Niskonlith Forest Reserve, in the marginal Douglas fir south of the South Thompson River and in the BX District northeast of Vernon.

1931—The infestations reported during 1930 persisted and many increased in size. Also, larvae were noted defoliating Douglas fir near Okanagan Landing.

1932—The population subsided throughout the areas of infestation.

1936—After an interval of four years, small outbreaks occurred in Douglas-fir trees near farm buildings in the Armstrong and Salmon Arm districts.

1937—Additional outbreaks appeared in groups of Douglas-fir trees about farm buildings near Armstrong. Small infestations occurred at Vernon.

1938—The infestations at Vernon and Armstrong increased a little in extent but no new outbreaks were reported.

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1. Contribution No. 401, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

2. Forest Biology Laboratory, Vernon, B.C.

3. The Agricultural Gazette of Canada, Vol. 6, No. 2, February, 1919. Notes on the Tussock Moth, Hemerocampa vetusta gulosa Hy Edw., by W. B. Anderson.

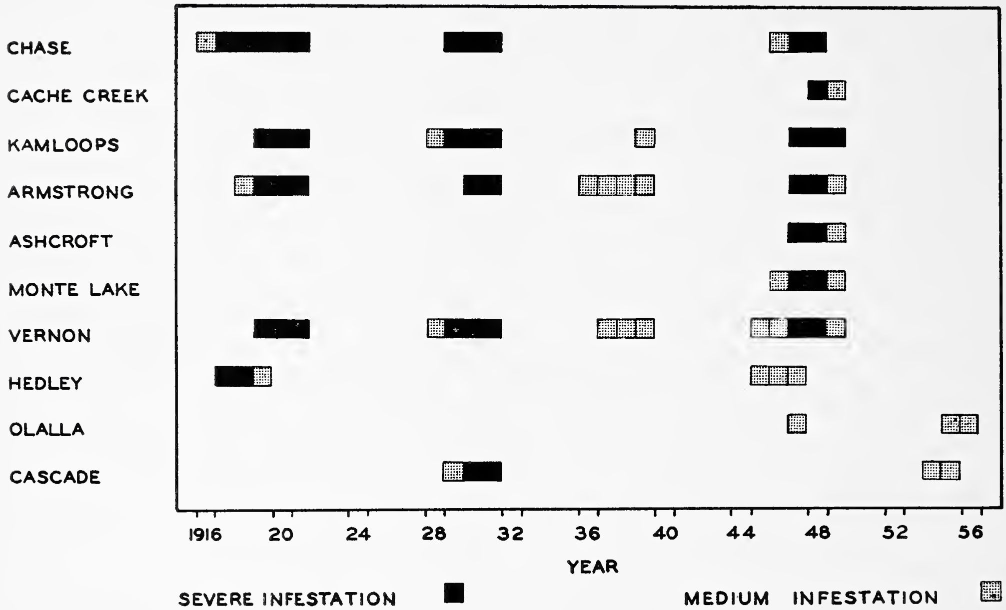


Fig. 1.—Records of occurrence of *Hemerocampa pseudotsugata* McD. infestations from 1916 to 1956 in the interior of British Columbia.

1939—The anticipated increase in population did not materialize. Although larvae were numerous during June and July near Vernon, Larkin, and Armstrong, there was a general population collapse apparently due to a virus. An outbreak reported from the North Thompson Valley during 1939 also subsided.

1945—The Douglas-fir tussock moth reappeared at Vernon and Hedley. Small outbreaks were observed near buildings at these localities.

1946—The infestations at Vernon and Hedley continued, and tussock moth activity was reported from Chase and Princeton.

1947—Young Douglas-fir trees near Chase, Squilax, Pritchard, Monte Lake, Stump Lake, Oregon Jack Creek, Hedley, Vernon, and Armstrong were severely defoliated.

1948—Damage by tussock moth larvae was widespread. Infestations were observed at Armstrong, Vernon, Oregon Jack Creek, Ashcroft, Lower Hat Creek Valley, Walhachin, North Thompson River Valley from Kamloops north to Barriere, and Monte Lake west to Monte Creek. Mortality of Douglas-fir and ponderosa pine trees occurred at all infestations.

1949—The infestations subsided. A survey in the spring of 1949 indicated that the only persistent large population was in the vicinity of Savona. This population collapsed during the summer due mainly to a virus.

1954—A small outbreak was noted at Cascade.

1955—The outbreak at Cascade subsided. A virus apparently was responsible. A light population was discovered at Olalla.

1956—Tussock moth activity near Olalla ceased during the summer. At the time of writing, the cause had not been determined.

From the above listed outbreaks of Douglas-fir tussock moth it is apparent that severe infestations have recurred at intervals (Fig. 1) in a rather limited part of interior British Columbia (Fig. 2). Most of the outbreaks have been in open-grown stands of Douglas-fir trees. The infestations appear to build up quickly in a relatively few suitable sites, last for a short period, and then collapse. Between outbreaks, there are years when

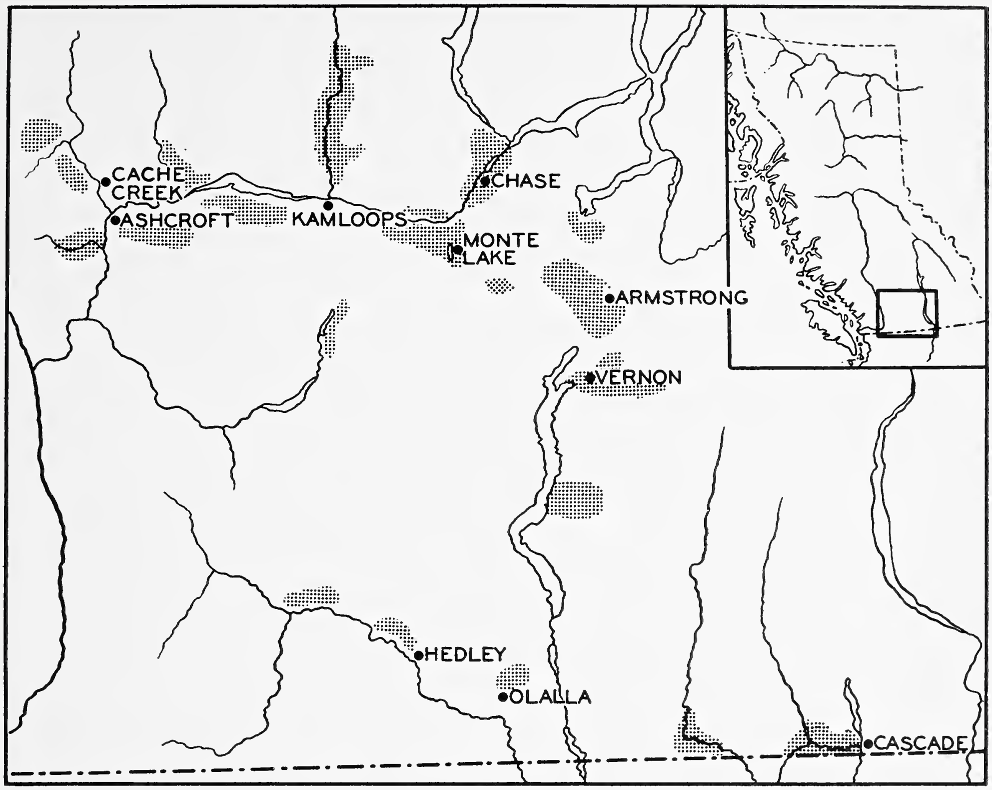


Fig. 2.—Location of past outbreaks of *Hemerocampa pseudotsugata* McD. in British Columbia.

no larvae are taken in the routine survey samples over most of the range of the Douglas-fir tussock moth. On the other hand, there are a few localities, such as Long Mountain near Oyama, where outbreaks have been unknown, but which usually have a small persistent population.

## *Caenurgina erechtea* **Blkme.**

The following notes are supplementary to my article on the species in the Proc. Ent. Soc. of B.C. **52**: 16-21, 1956

Ova were obtained from the summer form on July 20, 1956. These hatched on July 30. The larvae were fully fed about August 26, and pupated soon afterwards. Adults emerged September 21 to 26, all of the large summer form. Matings occurred and ova were obtained October 8, and for a few days after. Some of the ova hatched, but the larvae did not feed; the remainder failed to hatch though the embryos were fully formed.

From material in collections it was assumed that the summer brood would have overwintered in the pupal stage, giving rise to the small spring form. However, these observations suggest that two generations of the summer form are usual in this area; and it is conceivable that, given ideal growing conditions, and a long summer season, this species might be triple-brooded. In that case progeny from an early, third generation would develop sufficiently to produce overwintering pupae.—*George A. Hardy, Provincial Museum, Victoria, B.C.*

# NOTES ON THE LIFE HISTORIES OF FIVE SPECIES OF LEPIDOPTERA FROM SOUTHERN VANCOUVER ISLAND, BRITISH COLUMBIA

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The following notes deal with the complete life history of five species of Lepidoptera, from egg to pupa. These are: *Incisalia mossi* Hy. Edw., *Venusia pearsalli* Dyar, *Perizoma curvilinea* Hlst., *Spodolepis substriataria danbyi* Hlst. and *Xylomiges candida* Sm.

The food plants of the various species are either those given in "An Annotated Check List of the *Macrolepidoptera* of British Columbia" (Llewellyn-Jones, J. R. J., Ent. Soc. B.C. Occ. paper 1, 1951) or supplementary to them.

### *Incisalia mossi* Hy. Edw.

Since little seems to have been published on the life history of this species, the following notes may be of interest to students of the genus.

*I. mossi* is one of four species recorded for British Columbia. It is a small, inconspicuous, dark brown butterfly, rather local, usually found on steep, rocky slopes that face west, where the food plant, *Sedum spathulifolium*, grows abundantly. It flies from late March to mid-May.

To secure ova, females were repeatedly caged over various shrubs and trees during several years, but without results. Eventually it was noticed that the stonecrop, *Sedum spathulifolium*, was always near the haunts of *I. mossi*, and after caging the butterflies with stonecrop, ova were finally obtained and the caterpillars readily reared. Several caterpillars of different ages were studied, and the data obtained averaged for the following sequences.

**Ovum.** Ova deposited, singly April 14 to May 2, on the tip of the bracts or at the base of the flower buds; sometimes on the underside of the leaves near the inflorescence. Size, .75 by .33 mm. A somewhat flattened disc covered with fine reticulations that have raised hyaline margins giving the egg a hoary appearance and causing it to blend into the bloom-covered food plant. The micropylar area is deeply sunk below the surface and has smaller reticulations. Colour, a pale, pastel green matching the leaves. Hatched on or about May 1.

**Larva. 1st Instar.** Length 1.5 mm. Head piceous brown, large in proportion to the rest of the body, smooth, shiny. Body smooth, tapering from the head with no indication of the onisciform shape of the later stages; four longitudinal rows of small black dots each bearing a long, curved, white hair; the hairs on the thoracic segments directed forward, the remainder backward; length of hairs about equal to width of body. A small, dark brown plate on the dorsum of the first thoracic segment. The ninth abdominal segment flattened, rounded at the tip, held in a horizontal position; a small dark spot present on the dorsal surface at the base. Growth was comparatively slow at first; the caterpillars finally bored through the base into the heart of the bud where, hidden from view, they fed on the ovary and anthers.

**2nd Instar.** May 12. Length 5 mm. Head dark brown; body honey colour to greenish yellow, a faint lighter dorsal line, evenly covered with a short, dense, light brown pile. Onisciform shape now obvious, the head retracted within the first thoracic segment. Abdominal segments 1 to 7 with a pair of oblique, brownish stripes. Fragments of the bloom from the food plant entangled among the hairs helped to camouflage the caterpillars. At the conclusion of this stage they could be seen half in, half out of the flowers, or partly curled round the stem at the base.

**3rd Instar.** May 20. Length 10 to 12 mm. Fully onisciform, segments much ridged, folded and overlapping. A prominent lateral fold. Head piceous to dark brown. Body pale greenish yellow, matching the colour of the flowers; spiracles pink ringed with black; oblique stripes as before. In some caterpillars the stripes are faint or absent.

**4th Instar.** May 25. Length 16 to 17 mm. Head dark brown. Body greenish yellow, some caterpillars with stripes edged dorsally with white, spiracular fold whitish in some cases. May 28. Length 18 to 20 mm. Caterpillars mature; pupated May 31. Before pupation the caterpillars left the food plant and sought a sheltered niche. In confinement one caterpillar chose the side of a flower pot under some dry moss; others chose the bottom of the rearing jar. First they spin a light silk mat then over the fore part of the body a silken girdle which is attached to the mat. The tip of the last abdominal segment is also attached to the mat.

**Pupa.** Size 11 by 7 mm. Short and squat; pale yellow to beige at first, eventually becoming dark chocolate; a pale dorsal line flanked by a double row of small fuscous dots on each side. Spiracles white.

**Imago.** One emerged April 3.

One group of caterpillars ate the leaves and parts of the stems when confined over a plant from which the flowers were faded or absent. Caterpillars reared on the flowers were yellow, but those with the varied diet ranged from a dark vinaceous red through flesh-pink to greenish-yellow, with the oblique stripes more prominently marked.

*Venusia pearsalli* **Dyar.**

**Ovum.** A female taken in Saanich laid several ova May 6 and 7, 1956. Size .6 by .5 mm., slightly flattened. minutely reticulate, pale green, becoming darker just before hatching on May 14.

**Larva. 1st Instar.** Length 1.5 mm. Head pale translucent brown. Body semi-translucent pale, whitish-green. Very restless at first, nibbled at ocean spray, *Holodiscus discolor*, but finally fed on red alder, *Alnus rubra.*

**2nd Instar.** May 18. Length 4 mm. Head pale green, almost colourless, and translucent. Body pale green, with glaucous inter-segmental rings, and small, pale brown, tubercle-like dots, each bearing a short, white hair.

**3rd Instar.** May 24. Length 6 to 10 mm. Head translucent, greenish white. Body green, a dark, suffused, deep-seated dorsal line showing heart pulsations, thin white subdorsals, pale yellow intersegmental rings.

**4th Instar.** May 31. Length 15 to 17 mm. Head as before. Body apple green above, sage-green below, pale yellow, somewhat incomplete subdorsals, legs and claspers pale green, spiracles indistinctly greenish. Larvae hid among folded leaves when not feeding. Larvae full-fed on June 10, pupated between the leaves or in slight depressions in the soil.

**Pupa.** Size 8 by 3 mm. Shiny, lightly punctate, pale brown abdominal segments; cremaster about six spinous hairs, twisted together and set on a rugose base.

*Perizoma curvilinea* **Hlst.**

**Ovum.** Twenty ova from one female taken in Saanich, were laid irregularly on the bottom and sides of a chip box, August 13, 1956. Size, 1.0 by .75 mm., depressed oval, slightly larger at one end; smooth, with well defined reticulations; creamy white. Hatched August 22.

**Larva. 1st Instar.** Length 4 mm. Very slender. Head pale brown. Body colourless, semi-transparent with sparsely distributed short hairs. Did not eat the egg shell. Fed on ocean spray, *Holodiscus discolor*, after trying a number of herbs and shrubs.

**2nd Instar.** August 27. Length 7 mm. Head pinkish-brown. Body brownish-green blending into a lighter coloured, supra-spiracular line with its ventral border maroon; underside pinkish.

**3rd Instar.** September 3. Length 12 mm. Head milky-white with light brown feathering on sides and centre. Body light brown with short, scattered, black hairs.

**4th Instar.** September 9. Length 15 to 20 mm. Head sienna, with two vertical, whitish bars. Body pale rusty to sienna, with a faint pink tinge, spiracular line maroon, underside paler with a pale-bordered, dark, interrupted central line.

Full fed on September 18. Length 25 mm. Head as before. Body as before but with indistinct double dorsal, and single subdorsal lines; underside with two pale yellow lines slightly divergent on centre of each segment. Pupated September 22, within a slight cocoon among debris.

**Pupa.** Size 10 by 2.5 mm. Almost cylindrical, smooth, dull, red-brown; cremaster, two parallel spines recurved at tip in same plane and at top of a rugose conical base.

*Spodolepis substriataria danbyi* **Hlst.**

**Ovum.** A female taken in Saanich laid 14 ova April 23, 1956. Size, 1.0 by .9 mm. Oblong-oval, finely striate and cross-ribbed; pale cream, turning a salmon colour in a day or two. Hatched May 10.

**Larva. 1st Instar.** Length 4 mm. Slender, very active. Head light brown with darker mottlings. Body translucent purplish-brown, with two light lines; underside with two purplish stripes; body colour intensified on centre of some segments giving a ringed effect.

**2nd Instar.** May 15. Length 6 to 12 mm. Head square, pale pinkish, with three brown areas one on each side and one on the vertex. Body grey-green with several longitudinal lines; a faint, dark green dorsal, a white subdorsal, and a broad whitish spiracular line; spiracles ringed with black; underside with a wide whitish central band and a thinner one on each side; a pair of black dots on dorsum of each of abdominal segments two to seven. Fed on willows, *Salix mackenzieana* and *S. scouleriana*.

**3rd Instar.** May 21. Length 12 to 15 mm. Head whitish, heavily speckled with dark, greenish-brown, leaving two white bars on each side of the face. Body sage green, four black dots on dorsum of each segment, two pairs forward and two backward, with fine lines connecting the outer dots; the dorsal space between darker, and tinged with green; a conspicuous black line just below the spiracles; underside grey with a broad whitish central line; Thoracic segments with a central, black line on dorsum. Some larvae bluish grey with several thin, white lines breaking up the ground colour; spiracles black, a tinge of yellow along the spiracular line.

**4th Instar.** May 23. Length 22 to 25 mm. Head pinkish, heavily spotted with black on sides and top, leaving a white bar on each side continuous with sub-dorsals. Body colour and markings intensified, general colour grey to warm brown, imparted by fine brown vermiculations on a white and ochre base; dorsum of first thoracic segment with a black line, a pair of black spots on the second and third, the spots joined by a dark oblique line; a transverse black bar on the seventh abdominal, which has a corresponding raised ridge; hour-glass fuscous outlines on dorsum of abdominal segments. Some larvae have underside concolorous with dorsum; spiracles pink, ringed with black.

**5th Instar.** June 5. Length 28 to 35 mm. Head pale blue-grey, heavily spotted with fuscous, leaving two parallel vertical bars on the sides; Thoracic segments as before, first to seventh abdominal segments with suffused, diamond-shaped marks on dorsum; general colour light grey to sienna brown; underside pearl grey with wide, dark brown sub-spiracular line. Some larvae are uniformly sienna brown with no dark sub-spiracular line; dorsal pattern chiefly pale cream transverse marks between each segment. Larvae full-fed by June 8.

**Pupa.** Contained in a light cocoon spun on the surface of the ground under leafy debris. Size 14 by 4 mm. Slender, elongated, smooth, shiny; wing cases finely wrinkled; abdomen punctate around centre of each segment; dark, piceous brown. Cremaster, two stout spines, with recurved tips, subtended by 4 to 6 short, slender recurved hairs, all on a conical, rugose base.

### *Xylomiges candida* Sm.

This is a Western American species, on the wing from March to May. It may be found at rest on tree trunks by day and is attracted to light by night. Wing expanse 35 to 38 mm. the primaries mottled with light and dark grey, the secondaries satiny white, hence the specific name which means shining white. No referable account is available to me, and no mention of the food plant is recorded in Jones' list.

**Ovum.** A captured female from Saanich, land a group of about 110 ova May 10, 1955, piled together in three layers in a low pyramid. Size .5 to .3 mm., a flattened oval, vertically ribbed, shiny white with a light brown ring around the upper part, microplyar area marked with a brown dot, becoming darker at maturity; hatched May 30.

**Larva. 1st Instar.** Length 2 mm. Head light brown, dotted with black. Body transluscent purplish, with a few short hairs. The larva consumed the egg shell. Young caterpillars very active, soon scattering in all directions. They commonly spin a suspensory thread.

**2nd Instar.** June 10. Length 8 to 10 mm. Head pale greenish dotted with black. Body pale green to bluish, with black dots, each segment bearing a short hair; thin, white dorsal and sub-dorsal lines edged with fuscous. Spiracular line broad, white. Feeds preferably on broad leaved maple, *Acer macrophyllum,* but also feeds on *Salix scouleriana* and *Alnus rubra.*

**3rd Instar.** June 15. Length 20 mm. Head as before. Body varying shades of drab green, or brown, Thin, white dorsal and sub-dorsal lines sometimes present; spiracular line broad, white, edged dorsally with black.

**4th Instar.** June 22. Length 25 to 35 mm. Head pale brown with a small darker oblique stripe on each side of the vertex, and darker reticulations on the sides. Body red-brown with fine etchings and irrorations of fuscous. Dorsal and sub-dorsal as before; spiracular with a faint rusty tinge along the centre of the broad white band; spiracles white, ringed with black. Underside concolorous with the upper. Larvae full grown June 28; varying from pinkish-brown to dull, fuscous brown, with interrupted dark dorsal line, and little or no evidence of sub-dorsals. The fully fed larva was 40 mm. long. Larvae rest between the leaves, and curl into a ring when disturbed. July 9. Most of the larvae formed tough cocoons below the surface of the soil.

A larva taken on *Arbutus menziesii* July 3, 1953, matched the arbutus stems, a bright sienna. This one pupated on July 26 and emerged on April 15, 1954.

**Pupa.** Size 16 by 6 mm. Smooth. shiny, wing cases dark, piceous brown; abdomen light brown with short, dark streaks scattered over the segments. Cremaster, two stout, outwardly recurved, hooked spines, with four shorter, slender spines at the base; all placed directly on the tip of the last segment, and not on a raised tubercle as is commonly the case.

**Imago.** Emerged April 3 to 16, 1956.

# UNUSUAL DAMAGE TO POTATOES BY THE TWO-SPOTTED SPIDER MITE, *TETRANYCHUS TELARIUS* (L.), IN THE LOWER FRASER VALLEY[1]

H. G. FULTON[2]

Entomology Laboratory, Chilliwack, B.C.

Early in July, 1956, it was observed that the tops of late Netted Gem potatoes were browning and dying off in a 14-acre field at Sardis, British Columbia. Investigation showed that the damage was caused by large numbers of the two-spotted mite, *Tetranychus telarius* (L.)[3]. Infested areas were particularly noticeable at the edge of the field adjoining a ditch and hedgerow of weeds and brush. Later in July and during August similar damage was found in potato fields at Colebrook and Cloverdale. Although this mite has been recorded as a pest of potatoes in Washington and Idaho, this is the first time to the writer's knowledge that it has damaged potatoes in British Columbia. Large populations of the mite were also observed on sweet corn, pole beans, and marigolds at different locations.

1. Contribution No. 3648, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Technical Officer.
3. Identified by C. V. G. Morgan, Entomology Laboratory, Summerland, B.C.

The factors favouring the outbreak are not clearly understood. The summer was generally hot and dry but no records were set. However, general weather conditions must have been favourable for the rapid multiplication of the mites. A possible contributory factor is the widespread use of DDT to control the tuber flea beetle. Various researchers have shown that use of DDT is followed by an increase in the abundance of mites. Some say that the natural predators are killed (Pickett, 1949); others claim that mites exposed to DDT lay more eggs (Hueck, 1955); still others state that the insecticide brings about changes in plant nutrition and composition (Klostermeyer and Rasmussen, 1953).

The situation is worth watching since one or more of the recently introduced control practices for other potato pests may favour increase of the mite.

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## The Wharf Borer in a Vancouver Branch Library

In June, 1956, I was asked to investigate some beetles which the librarians of a branch library had found flying around the premises and had tentatively identified from literature as *Nacerda melanura* (L.), the wharf borer. Their identification was correct.

In volume 43 of the Proceedings of our Society, I published an article "An unusual record of the wharf borer in buried piling", reporting that this beetle bred at tidewater in piling that had been covered by a slab of concrete for thirty years. The branch library is a one-storey, 1500 square foot building, located on top of a little hill with natural drainage on all sides. There is no basement and only small ventilator openings in front, so that most of the floor is over a dead air space. In February, 1957, the library was closed for 10 days for repairs to the floor and I was able to procure half a sinkful of sodden black lumber which the carpenters had thrown out from underneath the floor. Some 16 *N. melanura* emerged from this material in the course of the next six weeks.

Adults of both sexes are most erratic in their movements, tearing around in all directions and then suddenly becoming motionless. A beetle will cover a territory for a considerable period like a hound on a scent and then suddenly dart off to another piece of wood or down a larval or a termite burrow, to emerge shortly and repeat the performance. Adults apparently need no food. One or two males will follow a female for long periods. Eggs are laid singly or in small groups, as far down into crevices as females can place them with their considerably extendable ovipositors. The eggs are 1 to 1.2 mm. long, white, long-oval, slightly curved or straight-sided. They hatch in from 5 to 7 days and the white larvae, 1.5 to 2 mm. long wander for days on the surface of sodden wood before boring in. Of two females dissected, one was nearly spent and yielded 35 eggs while the other, heavily gravid, contained 215 eggs of a uniform size suggesting that the full quota must be laid in a relatively short time.

This record shows that the wharf borer is spreading in Vancouver and may turn up in sodden timbers in the underpinnings of buildings which have poorly ventilated or completely saturated air spaces under them. Since the larvae feed only in sodden, rotting timber, the beetle is an indication of decay and not a cause of it.—*G. J. Spencer, Dept .of Zoology, University of British Columbia.*

## A further note on *Laelius* sp., Hymenoptera: Bethylidae, a parasite on the carpet beetle *Anthrenus pimpinellae* Fabr.

In Vol. 39 of the Proceedings of our Society I published a note with approximately the above heading except that the specific name of the beetle was given as *scrophulariae,* after an identification made for me by the late Ralph Hopping. At that time I had not taken *A. scrophulariae,* the Buffalo Carpet beetle, in this province, but within the last few years it has become established in homes in Mission and Haney. It may commonly be taken on white flowers at Mission, in summer.

From Hinton's book (Hinton, H. E. A monograph of the beetles associated with stored products. Vol. 1, Brit. Mus., 1945), I found that the beetles which Hopping called *A. scrophulariae* showed the colour patterns of *A. pimpinellae* var. *lepidus* Lec. Later when George Hopping arranged our beetles, he placed the specimens under *A. occidens* Csy.

This beetle is a scavenger in birds' nests, the larvae feeding upon feathers and the scales from pin-feathers left when fledglings have flown. I have reared them from cliff swallows' nests in the Chilcotin, and from tree swallows' and mountain blue birds' nests at Kamloops. Once at Quesnel I saw the blossoms of a small hawthorn swarming with beetles which had apparently just emerged from the cliff swallows' nests, which plastered the ends of a barn close by. The species is found at the Coast and is widespread in the Interior: I have specimens from Quesnel, Riske Creek, Kamloops, Nicola, Vernon, Salmon Arm, Trinity Valley, Merritt, Spence's Bridge and Victoria.

In 1956 the Department of Zoology received several cabinets of bird and mammal study skins, bequeathed to the University by the late James Wynne of Enderby. One of the boxes of about 12 cu. ft. capacity held some loose bird skins and from the bottom of this box I collected 11 pupal cases of *A. pimpinellae* of which 9 contained the mass of tight silk threads, indicative of *Laelius* parasitism, bulging above the level of the old larval skin in which pupae of dermestids typically occur. In most cases, a short emergence tube of the parasite extended up from each mass, opening either forwards or backwards. Loosening the silk with needles revealed from two to four others, underneath each tube, indicating that each beetle pupa had supported from three to five parasites. This is the highest degree of parasitism by *Laelius* that I have encountered, namely nine out of eleven pupae or about 80 per cent. Enderby is between Armstrong and Salmon Arm in the North Okanagan, but according to Dr. O. Peck (Proc. Ent. Soc. B.C. **39**: 21-22, 1942) Whittaker's type of *occidentalis* was taken from a window in Chilliwack, on the lower mainland. There is hope, therefore, that this parasite or a closely related species of *Laelius,* may become abundant in Vancouver where *Anthrenus verbasci* (L), the varied carpet beetle, is a household pest of the first magnitude.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

# THE EFFECT OF DOUGLAS-FIR LOG AGE ON ATTACK BY THE AMBROSIA BEETLE, *TRYPODENDRON LINEATUM* (OLIV.)[1]

*by*

J. M. KINGHORN AND J. A. CHAPMAN

Forest Biology Laboratory, Victoria, B.C.

*Trypodendron lineatum* (Oliv.), which flies in the first warm days of spring, prefers to attack trees felled the preceding autumn or winter rather than those freshly cut. Gaumann (1) showed that in Europe, spruce and fir felled from March to August were free from attacks by this species Attacks were heaviest on trees cut in October, November and December, although January-felled spruce was also heavily attacked. Observations by Hadorn (2) supported these findings. Among a 24-month series of hemlock cuttings conducted by Mathers (5), only logs older than five months were attacked by *Trypodendron*. Patterson (6) found from a series of hemlocks felled in different months, that average density of attack progressively diminished from 60, in December-felled, to 0.5 holes per square foot in April-felled trees. The same preference for autumn-winter felled trees was also shown for Douglas-fir, grand fir and western hemlock by Prebble and Graham (7). Exceptions have been recorded where trees felled as late as March and April have been attacked (4, 7), but in general, freshly cut trees are least attractive. The reason for *Trypodendron* preference of logs cut in autumn or winter is not yet clear. We recently conducted an experiment to determine the relation of attack density to time between felling and attack.

It is probable that both the quantity and quality of food reserves and other organic materials in the sapwood undergo changes after felling. If these changes are brought about by the continued functioning of living cells, it should be possible to arrest them by killing the cells. Wilson (8) demonstrated that prolonged functioning of the sapwood cells after cutting depleted starch in the sapwood of oak and ash. In contrast, the early death of these cells resulted in the maintenance of the starch reserve and therefore of susceptibility to *Lyctus* beetle attack.

Jover (3), in the Ivory Coast, increased ambrosia beetle attacks on Avodire eightfold by boiling the wood for 48 hours soon after felling. He suggested that the heat, by suppressing enzymatic action, prevented the depletion of stored starch which would occur under natural conditions.

## Methods

In planning the experiment, the following variables had to be considered in relation to the log aging process: (a) seasonal temperature fluctuations; (b) changes in log moisture; and (c) inter- and intra-tree variability in attractiveness to beetles. To minimize the effects of these variables, the following procedure was used. Two Douglas fir were felled February 7, 1956, and each cut into twenty-four 18-inch blocks. The blocks from each tree were then divided into six groups of four adjacent sections. One section from each group served as a control for the other three which received various treatments. The controls were essentially maintained as they were at time of felling by storing them in plastic bags at 0°F., after first waxing the cut ends.

Four series were aged as described below. From each tree, a set of blocks with the ends waxed were aged. Another series from Tree "A" was aged without waxing the ends. The fourth series, from Tree "B" was autoclaved at 20 pounds pressure for two hours before aging. This was done to simulate Jover's (3) boiling treatment and it undoubtedly arrested the cellular or enzyme activity in the

1. Contribution No. 400, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

sapwood. The bark was loosened on most of these blocks but it was tacked onto the sapwood immediately after autoclaving and the cracks coated with wax. Weight measures before and after autoclaving showed an average water loss of about one pound per block (blocks averaged 33 pounds).

All sections to be aged were placed in the basement of the laboratory where the temperature remained near 72°F. Moisture changes were minimized by standing the sections on moist sand and covering them with plastic bags. Every fortnight for 12 weeks, one block from each age-series was moved to refrigerated storage (0°F.), thus preventing further change.

On May 17, during a period warm enough to initiate *Trypodendron* flights, the blocks were taken from refrigerated storage to Cowichan Lake, where they were set out in a partly shaded clearing near a recently logged area where numbers of *Trypodendron* were likely to appear. All blocks were weighed just after they were cut, and again when they were placed in the forest. Most of them showed little change in weight, although the unparaffined, aged sections from Tree "A" had gained weight slightly. This increase can be attributed to water absorbed into the wood from the damp sand during aging. On July 16, the blocks were debarked and all *Trypodendron* attacks counted.

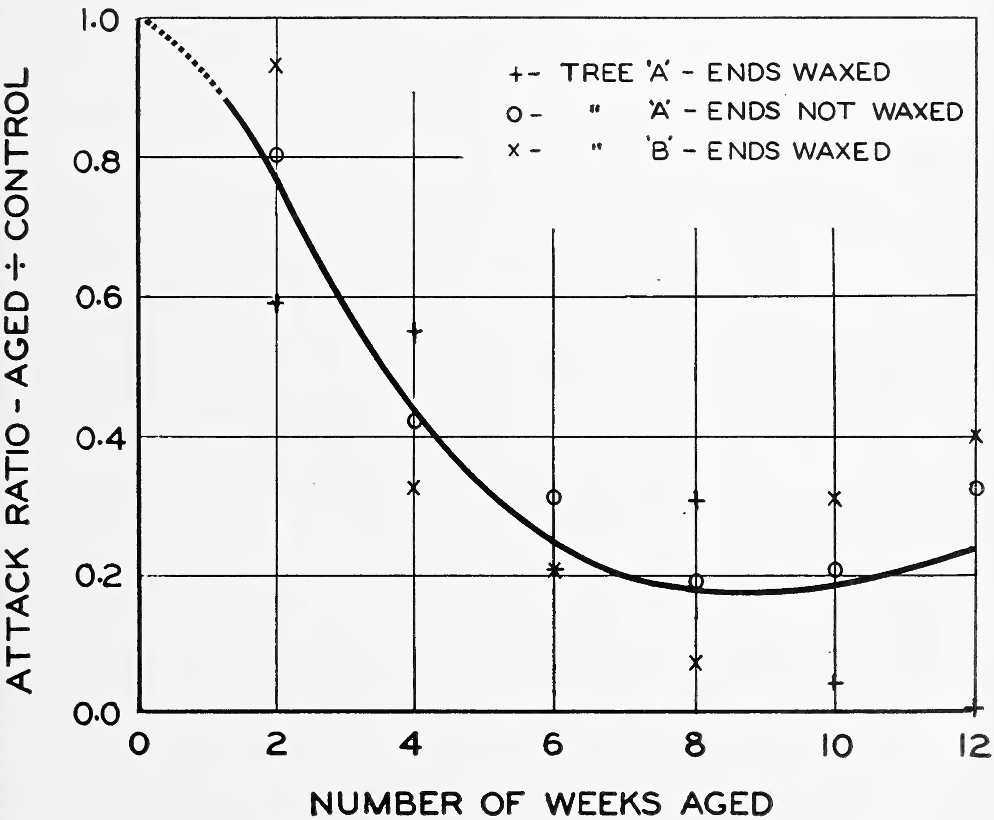


Fig. 1.—Individual values and free-hand curve showing the relation of attack on aged blocks (expressed as a proportion of attack density on corresponding control blocks) to length of time aged. The autoclaved series is not shown.

## Results

*Trypodendron* were noted flying near the logs during the first few days they were in the field, but after six days, only six attacks could be found, and five of these were on control sections. By May 29, however, 155 attacks were counted, 138 of which were on control blocks. The final examination, in July, also showed that the beetles preferred the un-aged wood (Table I). Among the groups that were not autoclaved, density of attack varied inversely with time of aging. This relationship is illustrated in Figure 1, where the attack preference is expressed as the ratio of aged-block to corresponding control-block attack density. The aged, waxed series from Tree "A" show a constantly declining attractiveness to the beetles for the entire 12-week aging period. Unparaffined blocks from Tree "A" and the waxed Tree "B" series show attack density decline for only the first six weeks of aging; blocks of these series aged longer showed no further decline in attractiveness.

It should be noted in Table I that the average attack values are almost identical for the aged and control logs of the first three series. One may conclude from this that differences between trees, and waxing of cut ends had little influence on attack.

In comparison with the other logs, those that were autoclaved received much less attack. Attack on the autoclaved-control blocks was less than half that on the other controls, and the autoclaved-aged series was almost free of attack.

The basal four-foot section of Tree "A" was not used for the experiment, but was left in the forest near Victoria where the trees were cut. It was interesting to find in July that this section had received 14.1 *Trypodendron* and 12.7 *Gnathotrichus* attacks per square foot. The combined attack density of the two ambrosia beetles was thus equivalent to that on the experimental control blocks at Cowichan Lake.

## Discussion and Summary

Although there was a high *Trypodendron* population present, and favourable weather persisted, the experimental logs were not attacked for several days after they were set out. This suggests that some change took place in the blocks after they were placed in the forest but before they were attacked. Any change which did take place however, did not obscure the treatment effects. The lighter attacks on the treated blocks indicate that both aging and autoclaving prevented the formation of,

**TABLE I.—Density of *Trypodendron* attack on aged and control Douglas-fir blocks.**

| No. weeks aged | Tree "A" Ends waxed | Tree "A" Ends not waxed | Tree "B" Ends waxed not autoclaved | Tree "B" Ends waxed autoclaved |
|---|---|---|---|---|
| | (Number of entrance holes per square foot) | | | |
| 2 | 19.9 (33.3)[1] | 9.2 (11.4) | 25.3 (26.0) | 2.9 (2.5) |
| 4 | 22.5 (40.6) | 11.8 (27.7) | 9.0 (27.8) | 2.9 (16.3) |
| 6 | 9.8 (46.0) | 6.7 (21.2) | 4.3 (20.4) | 0.7 (17.3) |
| 8 | 7.9 (25.3) | 12.5 (62.8) | 3.1 (42.4) | 0.7 (12.3) |
| 10 | 0.6 (13.3) | 5.0 (23.7) | 10.1 (32.3) | 0.0 (13.8) |
| 12 | 0.0 (16.5) | 15.2 (45.7) | 10.4 (25.9) | 1.9 (23.0) |
| Treatment Means | 10.1 (29.2) | 10.1 (32.1) | 10.4 (29.1) | 1.5 (14.2) |

[1] Density of attack on corresponding control blocks

or depleted some attractive substance. It is probable that the heat treatment destroyed or inhibited attractant formation. On the other hand, lessened attack on the unautoclaved aged wood may be attributable to continued cellular activity. Conditions duiing aging were similar to those described by Wilson (8) as favourable for prolonging the life of sapwood cells of oak and ash. Under such conditions, the living cells deplete starch reserves that reach a maximum during midwinter in these species. It is reasonable that this depletion principle applies to our aged Douglas-fir, but iodine tests both at the time of felling and after aging failed to reveal the presence of starch.

The experiment was limited in scope but it serves to point out the need for more information on the occurrence and seasonal fluctuations of various sapwood constituents in relation to ambrosia beetle selectivity.

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## On the iniquity of blanket sprays and dusts

One afternoon in 1946 as soon as DDT became available, I treated several quarter-acre plots on the Lac du Bois range north of Kamloops, with 3% DDT in diatomaceous earth, put out with a rotary hand duster, in the hope of controlling grasshoppers. Vegetation on the plots consisted of mixed grasses from 12″ to 18″ high and Russian thistle, and harbored several species of grasshoppers of mixed instars (hereafter caller groppers).

The plots were examined next forenoon. The effect on the groppers was negligible and continued so, but on some other insects it was literally shocking. Leafhoppers and mirids were wiped out and many dead and dying beetles, for the most part harmless, lay on the ground. Mr. Hugh B. Leech identified the beetles as: *Percosia extensa* Casey, *Harpalus basilaris* Kby. (*obesulus* Lec.), *Amara* (Celia?) *subaenea* Lec., and *Amara* sp. (Carabidae); *Cicindela longilabris montana* Lec. (Cincindelidae); *Coniontis oblita* Casey (Tenebrionidae); *Serica anthracina* Lec. (Scarabeidae); and *Brachyrhinus ovatus* (Linn.) (Curculionidae). *B. ovatus,* the strawberry root weevil is an important pest elsewhere but is harmless on a cattle range five miles from the nearest cultivated plants.

This dust tested again on Canada blue grass without weeds, killed off the large population of leafhoppers present and a few ground beetles. It was 12 days before the area began to be repopulated centripetally from the surrounding vegetation.

At Quesnel one afternoon in 1948 I dusted a considerable area of tall, sparse-growing alfalfa with 3% DDT dust to watch its effect against a heavy infestation of *Lygus oblineatus* Say and *L. elisus* Van D. and some leafhoppers; by next morning not one of these insects was alive on the plot and again it was nearly two weeks before the area began to be repopulated. The effect of the dust on insects other than Hemiptera-Homoptera was not observed.

At Vancouver one evening in early May 1957 I sprayed some lilac bushes and a tall privet hedge with a mixture of DDT and benzene hexachloride against the leaf miner *Gracilaria syringella* Fab. Next morning *Carabus nemoralis* Mul. beetles were lying paralyzed in some numbers up to 9 ft. from the hedge and others continued to die even 13 days after the spraying. Carabidae or ground beetles are very susceptible to modern residual insecticides. Every autumn numbers of *Pemphus angusticollis* (Mann.), *Carabus granulatus* L., and *C. nemoralis* Mul. find their way into the basement of our home and run over the floor which has had residual insecticides splashed on it and the beetles very soon become paralyzed and die.

These records show the possibly unavoidable slaughter of innocents, but the situation will become really serious in many large gardens in Vancouver which have fallen into the hands of men who glibly talk the owners into yearly contracts for periodical blanket sprays for controlling ALL insects. These operators use very powerful sprayers mounted on trucks with two large tanks containing two spray mixtures. The spray gun can throw a towering jet that will reach to the top of a 30-ft. tree, or, by a twist of the wrist, a very fine mist. In both cases the jet is almost of gale force, bending the vegetation right over.

I asked an operator what he was using and what insects he was supposed to kill: he had no idea whatsoever but stated that the company for which he worked had many contracts and he was working seven hours overtime per day to cover the ground. So he was drenching everything from tall Colorado blue spruce, Douglas firs and maples to border plants whether they needed it or not. I examined parts of one garden ahead of the spray and found no pests anywhere.

Granted that the vacua formed by such wholesale sprays will gradually fill in from surrounding properties, but the whole principle is wrong from a biological standpoint since it has been shown by many entomologists that modern residual insecticides may be more potent against parasites, especially Hymenoptera, than against the pests themselves.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

## BOOK REVIEW

Annual Review of Entomology, Vol. 2. (*E. A. Steinhaus* and *R. F. Smith,* editors). 1957. Annual Reviews, Inc., Palo Alto, Calif., pp. vii - 407.

The first volume in this series (1956) was widely and favorably reviewed. Now appears Volume 2, thinner by 59 pages but maintaining the high standard, and with it the prospectus for Volume 3. The bindings are good and the format attractive considering the limited budget.

Minor useful items are the running page titles of authors and subjects, the index of authors quoted and the adequate subject index. Less readily usable are the literature citations without titles, more than half of them arranged non-alphabetically. The brevity is necessitated by questions of space and economics, but the citations might be rearranged with little trouble.

The chapters originate as follows: from the U.S.A. 7, the U.K. 7. Canada 3, Australia 2, and Israel 1. The topics and authors follow: Digestion in insects, *D. F. Waterhouse*; Some aspects of intermediary metabolism of carbohydrates in insects, *M. Rockstein*; The physiology of insect cuticle, *V. B. Wigglesworth*; The comparative morphology of the insect head, *E. M. DuPorte*; Cytogenetics and systematic entomology, *M. J. D. White*; The taxonomic significance of the characters of immature insects. *F. I. van Emden*; Caste determinations in social insects, *M. V. Brian*; Dynamics of insect populations, *M. E. Solomon*; The synoptic approach to studies of insects and climate, *W. G. Welington*; Insect migration, *C. B. Williams*; Recent advances in veterinary entomology, *A. W. Lindquist* and *E. F. Knipling;* Transmission of disease agents by Phlebotomine sand flies, *S. Alder* and *O. Theodor*; Genetics of insect resistance to chemicals, *J. F. Crow*; The mode of action of insecticides exclusive of organic phosphorus compounds, *P. A. Dahm*; Chemistry and mode of action of organophosphorus insecticides, *E. Y. Spencer* and *R. D. O'Brien*; The behaviour of systemic insecticides applied to plants. *S. H. Bennett*, Aerial application of insecticides, *F. E. Weick* and *G. A. Roth*; Cotton insects and their control in the United States, *J. C. Gaines*; Insecticidal control of the spread of plant viruses, *L. Broadbent*; Pollination of alfalfa and red clover, *G. E. Bohart.* It is a healthy sign that among 72 authors in the 3 volumes is a good representation of young men in full research production, not all of whom are entomologists.

As source books the value of the series can hardly be questioned, either now when the backlog of papers is being reviewed, or later when the reviews are more immediately topical. The question is rather the personal one of whether they are worth 59 cents per month to a hard-pressed professional entomologist. The answer must surely be affirmative.

*H. R. MacCarthy.*

**The Collections of Lepidoptera in the Department of Zoology, University of British Columbia**

In 1929 the University purchased what was stipulated and understood to be the entire collection of macro- and micro-Lepidoptera from the estate of E. H. Blackmore. Since that time, however, the United States National Museum reported the gift from Dr. Gates Clarke of "the Blackmore collection of 2,000 specimens"; the Provincial Museum at Victoria reported the acquisition of "The Blackmore Collection"; and the late J. R. J. Llewellyn-Jones told me that he had seen notices of two sales of specimens of "the Blackmore collection of Lepidoptera". How many species and how many specimens the collection originally contained is impossible to say. The University received approximately 1,300 species of 9,900 specimens, but many of the species, especially in the Noctuidae, are represented by single specimens and in some cases by name labels only. There is one cabinet of duplicates and "material for further study".

Within the last three years we have received some valuable additions. When he sold his estate at Duncan, the late J. R. J. Llewellyn-Jones deposited his large cabinet at the University. It contained nearly 5,000 beautifully spread specimens on short English pins, of bright unfaded macros, ending with the Geometridae. This collection was willed to the University when Mr. Jones died. Through E. Ronald Buckell we received the collection made by his uncle, Dr. W. R. Buckell (see Proceedings, Vol. 43). These named, beautifully spread, perfect specimens, are housed in a tall walnut cabinet of 20 drawers. There are 541 species of macros and 232 species of micros, totalling 2,813 specimens, mostly from the Salmon Arm district.

By the will of James Wynne of Enderby, the University received his collection of macro-Lepidoptera the existence of which we had not known. For years Mr. Wynne had sent me valuable ectoparasites from birds and mammals and although we corresponded at intervals, he never mentioned being interested in Lepidoptera. His collection of 2,800 perfectly spread specimens is housed in 30 store boxes.

Both the Buckell and the Jones collections are separate units since they are mounted on short pins and cannot well be incorporated with others on long pins. The Wynne collection is on long pins and is being merged with the main Blackmore collection, which will henceforth be known as the Blackmore-Wynne collection. The Wynne collection is especially valuable since it contains some series of which we had few or no specimens, and some eastern North American forms.

Thus the University collection contains some 19,600 spread and named butterflies and moths of British Columbia and a few drawers of brilliant Tropical forms for demonstration, acquired a few at a time from various donors.—*G. J. Spencer, of Zoology. University of British Columbia.*

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# DIAZINON: A SUMMARY OF RECENT WORK ON A NEW ORCHARD INSECTICIDE[1]

D. P. PIELOU and M. D. PROVERBS[2]

Entomology Laboratory. Summerland, B.C.

This paper is an interim report summarizing, up to the present, the main findings of the Summerland Laboratory on the insecticide Diazinon.

Diazinon (Geigy Agricultural Chemicals, 1956) was introduced recently by the Geigy Company of Switzerland, the firm that produced DDT and, therefore, largely initiated the modern era of pest control. Apparently Diazinon was obtained in a search for an insecticide that would control DDT-resistant house flies; such a material besides having high insecticidal action, must have good residual action (on inanimate surfaces at least) and relatively low human toxicity.

Chemically, Diazinon belongs to the phosphoric acid ester group of enolisable heterocyclic systems. Described chemically as 0, 0-diethyl 0-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate, it is unusual in containing a pyrimidine, or 1, 3 diazine ring (a cyclic configuration of four carbon and two nitrogen atoms) together with an isopropyl and a conventional organic phosphate group. The expense of adding the pyrimidyl group leaves some doubt as to whether the price of Diazinon can be made competitive with other orchard insecticides. At present the technical chemical is imported from Switzerland and only the formulation is done in the U.S.A.

The data available on the toxicity of Diazinon to man and animals suggest that it is more toxic than malathion, but less toxic than parathion or TEPP, for example. According to Swiss workers (Buxtorf and Spindler, 1954), results on rats show that, by oral administration, parathion is about 60 times as toxic as Diazinon (so that Diazinon is approximately equal in toxicity to DDT). Malathion is almost harmless to rats, being about one-tenth as toxic as DDT or Diazinon. However, with week-old calves, U.S. Department of Agriculture workers (Radeleff *et al.*, 1955) obtained less promising results. Parathion, by oral administrations, was found to be twice as toxic as Diazinon, Diazinon 20 times as toxic as malathion, and malathion itself twelve times as toxic as DDT. DDT, as far as calves are concerned, is the least harmful material. The fact that DDT and malathion are reversed in sequence of toxicity, as between rats and calves, shows the difficulty of extrapolating such results to man and other animals on the basis of weight. Further, when the toxic action of dermal sprays on calves is considered, somewhat different figures hold. Parathion is then ten times as toxic as Diazinon, and Diazinon ten times as toxic as malathion. The last figures are probably the most valuable. In the surface-to-weight ratio calves are more like men than rats, and danger in the orchard is more likely to come from dermal effects than from oral ingestion.

One of the main points in favour of Diazinon as an orchard insecticide is that we have never observed any phytotoxic effects with either wettable powders or emulsions, even at much higher concentration than would ever be used in practice. And the likelihood of spray damage is a major aspect to consider in the introduction of a pesticide. We have not yet tested Diazinon against a full range of fruit varieties, in particular, against yellow varieties of apples, in which there are reports from elsewhere (Buxtorf and Spindler, 1954) of slight damage. As an example of our own results we

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may cite a comparative test of malathion, a material that is particularly likely to damage cherry, and diazinon. Malathion applied with a high-volume gun sprayer at eight pounds of 25 per cent wettable powder per 100 gallons (four times normal concentration) caused severe injury to cherry, moderate injury to apricot, and slight injury to peach. At double that strength the result was death, severe injury, or total defoliation to all soft fruits except prunes. But Diazinon at 30 pounds of 25 per cent wettable powder per 100 gallons (*i.e.* 15 times the recommended dosage) did not cause noticeable fruit or leaf injury to any type of fruit tree, including cherry.

High residual action and stability are claimed for Diazinon when used on walls. On living plant tissue the residual action is not necessarily the same. In lieu of specific chemical tests of deposit decline, long term action is demonstrated by satisfactory control of some insect for which effective coverage is necessary over an extended period. The codling moth, *Carpocapsa pomonella* (L.), the worst orchard enemy in British Columbia, is the best example of such an insect. A comparison was therefore made in 1955 by Dr. J. Marshall (unpublished) of the Summerland laboratory, using paired trees in an orchard heavily infested with the moth; one tree of each pair was sprayed with 50 per cent DDT wettable powder at 1.5 pounds per 100 gallons (12 ounces of active ingredient), the other with 25 per cent Diazinon wettable powder at two pounds per 100 gallons (8 ounces of active ingredient). Seven tree pairs were used. Two cover sprays were applied against the first brood and one against the second brood. At the end of the season the percentage of wormy fruit were: DDT, 12.9; Diazinon, 12.4; unsprayed checks, 79.1. In 1956 further trials were carried out in another heavily infested orchard. In this instance a concentrate sprayer was used, and four cover sprays of 25 per cent Diazinon wettable powder were applied at nine pounds (2.25 pounds of active ingredient) per acre. For a comparison, 50 per cent DDT wettable powder was applied at six pounds (three pounds of active ingredient) per acre. Both these rates are somewhat lower than would be used commercially. At harvest time the percentages of wormy fruit were 10.7 in the DDT plot and 4.8 in the Diazinon plot. In view of the high infestations in both orchards, and the concentrations of active ingredients that were used, there is no doubt that Diazinon was at least as effective against the codling moth as DDT. In the latter orchard the eye-spotted bud moth, *Spilonota ocellana* (D. & S.), was also abundant and the percentages of fruit showing typical injury by this pest at harvest time were: DDT plots, 10.1; Diazinon plots, 0.8. In another orchard 25 per cent Diazinon was applied as a single dilute spray at two pounds per 100 gallons against the bud moth on apple and cherry trees; control was nearly perfect.

A special point of interest with Diazinon is the very wide range of orchard pests that it is effective against. Particular insecticides aften prove to be effective against a particular group of insects — soil or cotton insects, for instance. Up to the present there has been no single insecticide with a wide "spectrum" against orchard insects. DDT and parathion together, or DDT and malathion together, have been the nearest approach to this. Diazinon we consider to be an insecticide that will do all either of these combinations will do, and perhaps something more as well.

Diazinon is therefore a "general" insecticide. In the past, when entomologists in British Columbia were more concerned about hypothetical dangers from the destruction of parasites or predators, they were more prone to recommend selective insecticides as a safeguard. It appears to the authors, however, that disharmony (sufficient to cause economic loss) between chemical control and natural control of insects by indigenous enemies has been overstated, at least under the conditions of the semi-arid

British Columbia interior. Further, biological control with introduced parasites plays a minor part among all but two orchard pests in this part of British Columbia. There is, therefore, a lessening of interest in British Columbia in highly selective insecticides (which mean a multiplicity of materials and costs) and a revival of interest in more general insecticides that promise cheaper, or, at least, simpler spray schedules; this point of view is readily appreciated by the grower.

The effectiveness of Diazinon against the codling moth has already been mentioned. This is important from another aspect. Resistance to DDT, which was developed quickly in species like house flies. is, after a longer period of grace, beginning to appear in the codling moth. In one area of Australia it is extremely high (Smith, 1955); it is noticeable in parts of the eastern U.S.A. (Clancy, 1955) and there are reports of measurable increases in resistance from Washington State. It may be expected in British Columbia in time. Diazinon appears to be an answer.

Against aphids, both on apple and on stone fruits, the material is excellent. At one or two pounds per 100 gallons perfect control has been obtained against the black cherry aphid, *Myzus cerasi* (F.); the green peach aphid, *Myzus persicae* (Sulz.); the mealy plum aphid, *Hyalopterus pruni* (Geof.) [= *H. arundinis* (F.)]; the thistle aphid, *Anuraphis cardui* (L.); the woolly apple aphid, *Eriosoma lanigerum* (Hausm.); and the apple aphid, *Aphis pomi* Deg. Against the black cherry aphid, Diazinon seems to have a special place, because malathion readily damages cherry, parathion is not recommended because of toxicity to human beings, lindane is apt to taint the fruit, and nicotine is often ineffective at low temperatures early in the season when spraying is necessary. Even if a grower has failed to spray early in a season, when other aphicides are most valuable, he can get adequate control of the black cherry aphid with a summer application of Diazinon even though the aphids are then protected by the tightly curled foliage. Similarly, the green peach aphid was perfectly controlled in 1954 with Diazinon, in an orchard where malathion had earlier proved unsatisfactory. With the apple aphid, however, re-infestation from neighbouring orchards is a constant problem and against that species Diazinon has been no better than malathion or lindane. Under the severe aphid attacks of 1955 and 1956 repeated spraying was, therefore, necessary with Diazinon as with other materials. In commercial orchards it is expensive to apply insecticides repeatedly for aphids only. However, if the insecticide is used for other purposes (*e.g.*, Diazinon for the codling moth cover sprays), repeated application may be economically feasible.

Diazinon gives good control of overwintered nymphs of soft scales, *Lecanium* spp., on peach and apricot. It is also effective as an early summer spray against the San Jose scale, *Aspidiotus perniciosus* Comst.

Against orchard mites, Diazinon, in a single application, has given very good results against the active stages of the clover mite, *Bryobia arborea* M. & A. (*B. praetiosa* of authors, in part); the European red mite, *Metatetranychus ulmi* (Koch); the yellow mite, *Eotetranychus carpini* (Oudms.) [=*E. carpini borealis* (Ewing)]; the McDaniel spider mite, *Tetranychus mcdanieli* McG.; and the apple rust mite, *Vasates schlechtendali* (Nal.) (Downing, 1957). However, residual control is not so good as with specific miticides. But if Diazinon were applied in the repeated cover sprays for codling moth control, growers would probably be little concerned with mites unless phosphate-resistant strains of the European red mite were present. Diazinon is not effective against such mites. At the present they pose a major problem for which specific miticides are required. Apart from this, however, Diazinon has an advantage over specific miticides in that most of them have a tendency to dmaage foliage.

We have done no tests with Diazinon against the rosy apple aphid, the pear psylla, "cat facing" bugs, or cherry fruit flies, but results from elsewhere indicate that Diazinon is very effective in these cases.

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## TICK PARALYSIS IN CATTLE IN BRITISH COLUMBIA IN 1957[1]

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Several serious outbreaks of tick paralysis in cattle were caused by the Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, in the Nicola-Kamloops area of British Columbia in the spring of 1957. These were favoured by prolonged tick activity during a late spring, and by lack of, or inadequate, spraying of animals with BHC. Several rain showers also served to weaken residues that originally may have been sufficiently strong to afford normal protection from the ticks.

The first outbreak occurred on April 10 at the J. Lauder ranch, Merritt. Three hundred yearling cattle, which had not been bothered by ticks during the past three years and hence had not been sprayed, became infested with clusters of several dozen engorging ticks per animal. Ten were paralyzed in the field; three of these died. The remaining animals were rounded up and sprayed the following day with BHC at the recommended rate of 4 ounces of wettable powder (Ortho BHC 10 Wettable, 10 per cent gamma isomer; California Spray-Chemical Corporation, Portland, Oregon) per gallon of water.

On April 19, at Drew's ranch, Stump Lake, 32 yearlings in a herd of 118 became paralyzed. The herd, which had been sprayed with BHC wettable powder (Ortho BHC 10 Wettable) at 2 ounces per gallon of water two weeks previously, was resprayed; and stricken animals were deticked in the field and each given 600,000 units of penicillin to safeguard against pneumonia. Seven animals died.

The following day a large outbreak was reported by the Nicola Stock Company at what is known locally as the Saxon Field, about six miles up Quilchena Creek. This area has been heavily infested with ticks for many years, and in 1944, in a derris-sprayed herd of 1,230 yearlings, 400 were paralyzed and 50 were lost. In 1957, the herd had been sprayed with BHC, but at only ½ ounce of wettable powder (Ortho BHC 10 Wettable) per gallon of water, resulting in little residual protection. When the writer visited the area on April 21, nine cowboys were searching some ten square miles

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Some of 120 cattle that were paralyzed by ticks while being held overnight for treatment with BHC.

of rangeland for 200 paralyzed animals. Many of the cattle had collapsed in creek bottoms and underbrush and were suffering from exposure. The more advanced cases were completely immobilized; some had already been attacked by magpies and coyotes. Others were able to sit up. Their behaviours varied from glassy-eyed helplessness to complacency. As they were discovered the engorging ticks were combed off or doused with diesel oil. Most of the animals recovered by the following day, and only about 30 were lost. The remaining 500 unparalyzed but heavily infested animals were rounded up and driven four miles to the nearest corral. By next morning, when equipment was assembled for BHC spraying, 120 of these had become paralyzed. All these recovered completely although some were still unable to walk steadily two days later. Two were drowned while attempting to drink at a nearby lake. In addition to the total animal losses, the owner suffered losses from animal shrinkage due to movement and lack of food, and in wages for manpower.

Another outbreak occurred at the W. Davis ranch at Mammot Lake on April 26, when 14 yearlings in a herd of 70 became affected. All recovered after an emergency treatment of coal oil and crankcase oil, followed by a BHC spray. This was the first time that this rancher had cattle paralyzed by ticks during his thirteen years of ranching in this valley.

## Summary

In 1957, four outbreaks of paralysis occurred in cattle from attacks by the Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, in the Kamloops-Nicola districts of British Columbia. In herds of 300, 118, 700, and 70 yearlings, 10, 32, 320, and 14 animals respectively were paralyzed, with losses of 3, 7, 30, and 0 respectively. The outbreaks were favoured by a combination of prolonged tick activity and insufficient protection from BHC sprays due to showery weather and inadequate dosage.

# THE INSECTS ATTACKING STRUCTURAL TIMBERS AND FURNITURE IN HOMES IN COASTAL BRITISH COLUMBIA

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Arranging wood-eating and timber-destroying insects of coastal British Columbia in order of wideness of distribution and frequency of occurrence, we have: termites; carpenter ants; the golden Buprestid; the dry rot beetle; the anobiid *Hadrobregmus destructor*; the European furniture beetle; the longicorn *Opsimus quadrilineatus*; the powder post beetle *Lyctus brunneus*; the garden ant *Lasius niger* s. sp. and the wharf borer.

## Termites

Three species of Termites are indigenous: *Zootermopsis angusticollis* (Hagen), the damp wood termite, found on the west coast of Vancouver Island, around Victoria and at Nanaimo, on the mainland coast from the international border to Prince Rupert, around Salmon Arm and Revelstoke and perhaps at Quesnel Lake; another damp wood termite, *Z. nevadensis* (Hagen), occupies much the same territory but less commonly; and *Reticulitermes hesperus* Banks, the subterranean or dry land termite, which occurs in the Dry Belt from Osoyoos, up the Okanagan Valley to Kamloops and from Lytton to Lillooet, on Vancouver Island on the eastern dry side from Victoria to Nanaimo and on some of the gulf islands.

*Z. angusticollis* is far more widespread than is generally recognized. It is particularly bad in townsites carved out of heavy timberland, such as Powell River, and in old logs on the coast that lie half embedded in sandy beaches, which serve as reservoirs from which flights emerge during August and into September.

The establishment of colonies of the two damp wood species apparently comes about by the winged reproductives spreading widely in all directions and coming down randomly against the sides of buildings where they may succeed in founding a colony in places where the wood is very damp or where damp earth is in contact with the sides of the house. All others not finding such areas of soggy wood, must perforce perish. Opposed to this theory is the supposition that males and females in flight detect from a height of hundreds of feet in the air, very limited areas of damp or rotting wood, and drop down to found colonies therein. This would seem to be beyond the powers even of these remarkable insects. The bases of old telephone poles are susceptible to termites, especially those that are surrounded by tall grass and weeds. I have one record, however, of a flourishing colony in a telephone pole isolated three feet above the ground where the insects were able to survive by the moisture maintained by rains beating into wide cracks in the pole. These insects require an almost saturated atmosphere in which to nest; given such conditions, they sometimes tunnel into solid dry wood as much as six feet from the damp nesting area, obtaining the necessary humidity by sealing up tunnels to produce dead air spaces. I have another record of a flourishing colony far removed from damp earth, where the termites were doing much damage to one of the upper floors in a 6-storey concrete warehouse; the floors were of 2 x 6-inch laminated planks and the infested floor must have been subjected to persistent, slow leaks either from pipes or the roof, to provide the decay in which the termites flourished.

Woodwork in dead-air crawl spaces beneath one-storey buildings, is very susceptible to termite infestation as is that in partly excavated basements and most particularly, the woodwork under enclosed front steps of stucco houses or the cribbing left behind by builders under concrete steps leading up to houses. From colonies in such concrete-enclosed spaces, reproductives may emerge in swarms from exit tunnels cut for them by workers, through oak flooring in halls or through sills or walls on each side of the steps. Another susceptible point is woodwork behind brick planter-boxes up against buildings where moisture seeps through the bricks or when the metal boxes rust through several years after construction. Such colonies are difficult to destroy because it is so hard to reach them except by removal of the bricks.

Colonies of *Zootermopsis* in this region do not make earthen and frass tubes up the sides of buildings in order to cross concrete walls and to reach woodwork out of contact with the earth. Only once have I seen these tubes, three of them, over three feet long under the steps of a house where the insects had riddled all damp wood and were migrating sideways into a dry 2 x 6-inch sill and into dry 2 x 4-inch studs; the tubes had been dropped *downwards* from the dry wood to obtain moisture from the damp earth at the base of the wall. Two of the tubes had reached the earth and the third had almost reached it and was in process of being built when I examined it.

Sawdust bins in basements, made of ship-lap on 2 x 4-inch studding, holding wet, old, decaying sawdust, are often heavily infested with termites, even to the $\frac{3}{4}$-inch boards themselves. The infestation may spread even to the lath of stucco walls. I have a record of the north and east sides of a bungalow where all woodwork was so destroyed that daylight was visible through many parts of the walls; the joists and sills of the living room above were perforated and the front steps had to be replaced; the damage was estimated at $2000.

The best treatment for termites in this region is to replace all infested wood with new, treated timber and to spray the termites as they are exposed. Soil treatment is not necessary. If damage to beams is not very extensive and the colony is small, spray or dust can be blown in through holes drilled for the purpose. Since coastal species do not throw up tubes to reach wood lying above concrete walls, it is unnecessary to equip houses with angled metal stripping above the concrete or brick foundation walls. Damp earth touching wooden or stucco walls, leaking roofs and blocked tile drains are the chief causes of termite infestation and the first things that should be remedied.

Although slight damage to homes and other buildings is very widespread in Vancouver and severe damage is not uncommon, no houses have collapsed as yet in the city. In Victoria where all three species of termites occur, two houses have been reported to have collapsed and one each in Kamloops and Kelowna where only *R. hesperus* occurs.

### Carpenter ants

Not so widely distributed as termites but causing very severe damage where they do occur, are carpenter ants, *Campanotus herculaneus* var. *modoc* M. Wheeler. They excavate tunnels in very dry wood remote from contact with damp earth *and* they are infinitely harder to get rid of than termites unless their nests can be located at once. They do not work in darkness or in an atmosphere of 95 per cent saturation as do termites, but they forage outside and thus reveal their presence, as they do by throwing out sawdust from the tunnels. Although they excavate very dry wood and have exits almost anywhere, the nests and nurseries are always in damp spots, sometimes of very limited size, such as may be produced by rain oozing through a nail hole or between a sill and the top of a concrete wall. The nests are usually difficult to locate and while they are often under window sills or in window and door frames, they may be in corner posts, studding of walls, floor joists, rafters, under hand split shingles or even between sub-flooring and hardwood floors. In both small and especially in large houses, several nests may be present and ants may wander out into every room.

In log houses especially, carpenter ants may work for years without arousing suspicion, often chewing out soft, summer wood in concentric rings between the hard, winter check wood, until one side of the house begins to settle. By that time the only thing to do is to replace the logs one at a time starting from the bottom.

Colonies may start in several ways. In older houses in built-up areas, colonies generally start from over-wintered "queens" that were fertilized on a marriage flight; such colonies take at least three years to become evident. Or a colony may become established in a house from long-piled firewood or from infested timbers salvaged from another building. Old stumps left in corners of hill-side homes often contain colonies and it is a matter of time before the ants move into the house itself especially if the stump is rooted up and the ants allowed to survive. When houses are being built on newly cleared soil long-established ant colonies may be disturbed and may move *en bloc* into the new houses. If the houses are of post-and-beam or Panabode type in which the tongue-and-groove lumber does not always fit tightly, ants may make runways sometimes the full length of a house. I have seen a quart of ant sawdust dumped into a switch box in a huge Panabode house that had been occupied less than six months; one could hear the ants rasping away all over the house.

When a large house is infested it is generally difficult to locate the nests without stripping off the stucco or sheeting. When nests cannot be located and the whole colony destroyed, it is necessary to put down a residual insecticide right around a house and to maintain it all summer, destroying the colony by attrition, a process that may take one whole season or even two. The feeding places of ants should be located by watching foraging workers which often get honey-dew from aphids on Douglas fir trees or from the glands on the petioles of laurel bushes; the marching columns can be sprayed with three to five per cent chlordane.

Where colonies are known to be living in large beams, injections into the wood through drilled holes, of a 50-50 mixture of creosote and kerosene, will cause hordes of ants to pour out, when they can be sprayed. This is permissible in basements or in raw wood but in painted or papered walls which would be spoiled by the brown stain of crude creosote, it is better to use a solution of carbolic acid.

## Golden Buprestid

For frequency of occurrence and wide distribution the golden Buprestid, *Buprestis aurulenta* Linn. ranks high, although it is rarely abundant enough to cause much damage. I have many records of emergences from buildings ranging from 5 to 50 years of age with most emergences coming in the 12 to 30 year range. The larvae of this beetle can persist in wood longer, I think, than those of any other insect in any other medium. In August, 1931, at Aspen Grove near Merritt, I cut up a pine tree of 8-inch diameter, into slices $\frac{3}{4}$ to $\frac{7}{8}$-inches thick and stacked them; *B. aurulenta* laid eggs in the topmost slice. The wood was brought to Vancouver in September and laid on a shelf in the laboratory; soon afterwards, very fine boring dust was thrown from minute tunnels in the infested slice. The slice was thin so the larvae moved from side to side of it throwing out sawdust at intervals until September, 1951, when we moved into another building and the larvae died, exactly 20 years after the eggs were laid and even then they were only one-third grown. The 50-year record concerned emergence of adults from pews in a church in Alberni, Vancouver Island. (4).

From one to five beetles only emerge from any one house of average construction, but in some log houses currently under observation, especially one enormous residence built in 1931 of whole logs, thick slabs and thin stair posts, beetles emerge every year by the dozen. In 1957 one emerged from a banister as I was walking up the stairs. Everything points to females of this beetle laying eggs in crevices in recently cut timbers in log houses and larvae therefrom, developing in this slow-drying wood without having to feed for several weeks in the cambium layer as do the larvae of most buprestids. I have noted beetles running in and out of their own and former exit tunnels and from the scores of holes in one verandah post, I am convinced that eggs were laid in it over a period of years and larvae successfully developed in it.

Only two pieces of 2 x 4-inch wood have come to my attention which were absolutely riddled by larvae of this beetle, completely destroying them. Both larvae and beetles were recovered from this wood so there can be no question about the identity of the species. An intensive study of this beetle is long overdue.

### Dry rot beetle

Also high in frequency of occurrence but of little consequence, is the anobiid beetle *Coelostethus quadrulus* (Lec.) which I have called the dry rot beetle. Dry rot is common in the lower Fraser Valley, especially in homes where tile drainage is blocked or absent and woodwork becomes damp. Sooner or later the diseased parts are discovered by this beetle, even small spots some two inches square in remote corners of a basement. Woodwork in damp, dead-air spaces almost invariably develops dry rot and equally surely this beetle infests the affected parts.

It is an effect, not a cause and of little consequence since it does not attack sound wood.

### Hadrobregmus destructor Fisher

Also in houses, summer homes and lakeside log cabins, occur extensive perforations made by another anobiid *H. destructor,* (2) whose emergence holes in dry posts under a house sometimes look like a scattered charge of No. 10 shot. Fortunately, attacks by this beetle are generally restricted to sapwood and do not materially reduce the compression strength of the wood. However, in a timber or plank consisting mostly of sapwood, the damage may be very extensive resembling that of true powder-post (*Lyctus*) beetles. A small ant-like, wingless hymenopteran sometimes parasitizes the larvae of this beetle in their tunnels, but it is never sufficiently abundant to wipe out the pest.

### European furniture beetle

Increasingly frequent infestations of homes are occurring in Vancouver, of the European furniture beetle, *Anobium punctatum* DeGeer, erroneously called the death-watch beetle. These arise from heirloom furniture imported from Europe or from antique furniture purchased locally. From these sources, the beetles may spread throughout the house; but they attack chiefly Douglas fir sapwood occurring in the basement. From furniture in the upper part of a house, beetles may infest oak or maple floors and then spread into the basement. They perforate hardwood very thoroughly and also attack curved surfaces of log furniture and walls.

### Opsimus quadrilineatus Mann.

A very unusual record is that of this longicorn, which was extremely plentiful in the enormous log house mentioned earlier. In one measured linear foot of a post of 7 inches diameter, occurred 91 emergence holes. Two varnished 30-foot key posts supporting the roof, were similarly perforated. Each mature larva throws a cascade of sawdust out of the oval hole it cuts to the surface and then retires backwards to pupate inside the tunnel.

This is one insect that definitely oviposits in its old tunnels and in those of *B. aurulenta* into which it readily retreats when alarmed. I have studied the newly-hatched *Opsimus* larvae burrowing into the walls of old buprestid tunnels where the eggs were laid, throwing out behind them cascades of minute particles of sawdust and frass. Adults of this brown, 18-22mm. beetle are very active, flying freely around a house by day and by lamp-light; they are also active in dim light as in a windowless basement.

This insect infests chiefly the curved surfaces of varnished and unvarnished vertical posts and horizontal logs. However, I have a record of one larva each, attacking two 6 x 6-inch beams in one house, and another record of a heavy infestation in a short length of 2 x 3-inch wood which must have been infested when the wood was freshly cut, before it was painted.

Log houses in heavily wooded areas and the shady side of other log houses are more subject to attack than those out in the open.

### Powder post beetle

*Lyctus brunneus* (Steph.) occurs sporadically in Vancouver, emerging from oak floors, usually within one year of the floors being laid. They do not reinfest the house. They occur mostly in ¾-inch grooved and tongued mill-end strips imported from some five southern states. All oak flooring is required to be kiln-dried before being exported, but eggs are apparently deposited in the strips after being dried and while piled in yards, before it can be shipped.

The firm importing most of this oak flooring brings in several million feet annually and considering the huge amount imported, infestations are relatively uncommon. Retail flooring firms replace infested pieces without dispute.

Infestations of *Lyctus planicollis* Lec. occasionally occur in imported furniture and another species not infrequently destroys bamboo articles shipped from China or Japan such as strip screens, picnic baskets and garden posts. Usually this occurs within one year of the goods being brought in.

### Garden ant

The last insect of any consequence that infests woodwork in local homes, is the common garden ant *Lasius niger* s. sp. which often becomes established in timbers that have been wet for a long time and are rotten at the centre. Sills lying on concrete walls and sills below windows that are dampened by contact with outside earth; studding inside a wall that is drenched from a leaking roof and soggy timbers under concrete steps — all these may become infested and completely tunnelled by colonies of this ant. Every summer large flights of reproductives of both sexes, the brown and yellow females ten times the bulk of the black and brown males, pour out into the house causing great alarm. Sometimes flights develop in nests in the ground adjacent to walls and the winged forms move into the wall under the siding or stucco and emerge into the rooms from behind the quarter-round or baseboard, giving the impression of having developed in the wall itself. Removing the cause of the dampness and replacing the sodden wood, is the answer to this trouble.

### Wharf borer

*Nacerda melanura* (Linn.), the wharf borer (3), seems to be spreading widely in Vancouver. It came to my notice first in 1945 in piling at a sugar refinery. In 1952 one specimen was sent me from a greenhouse on the property of this same refinery. In 1957 a very large number of beetles emerged from under the flooring of the branch library at Kitsilano where sodden timbers, rotting in a dead-air space, were perforated by larvae and beetles. During April-May, 1958, an immense number of beetles infested a black-topped parking lot in the heart of downtown Vancouver. The owners said that this was the third year that the beetles had appeared but never in such numbers and they were causing great alarm. Emergence was from cracks in the asphalt around a small concrete office. The manager mentioned that timbers from large wooden buildings formerly on the site, were buried under the present office so the flood of beetles must have come from this rotting wood. Like the swarms of *Lasius niger*, the presence of these insects is an effect, the result of sodden wood and not the cause of wood decay.

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## DISTRIBUTION OF STORED FOOD INSECTS IN BRITISH COLUMBIA[1]

PETER ZUK[2]

This is a report of a continuing survey of grain elevators, cereal warehouses, and flour mills in British Columbia for the seven years 1952 to 1958, to determine the distribution and relative importance of established stored food insects.

A few reviews have been published on these pests in British Columbia. Follwell reported on the Ptinidae in cereal warehouses (1952) and issued a circular on stored product insects and their control (1953). King (1953) assembled some information on these pests and Gray (1953-56) listed the ones most commonly found. Spencer (1942) recorded some of the common forms occurring in dwellings.

The present survey consisted of visits to establishments in the large centres in the province, from Vancouver to Cranbrook in the south and to Prince George in the north. On Vancouver Island warehouses were inspected from Victoria to Courtenay and Port Alberni. In the interior and on Vancouver Island inspections were made during July or August only, but on the lower mainland they were made throughout the year.

An inspection consisted of a check of the premises for crawling and flying insects and an examination of the stored food in sacks and in bulk. Some specimens were obtained by screening samples. The insects taken were often brought to the laboratory to be reared and questionable specimens were submitted to the Systematics Unit, Ottawa, for identification.

A total of 584 visits was made to establishments during the seven years, in which 35 species of insects were recorded:

| Year | Firms visited | Species |
|---|---|---|
| 1952 | 101 | 21 |
| 1953 | 108 | 25 |
| 1954 | 80 | 16 |
| 1955 | 76 | 17 |
| 1956 | 40 | 14 |
| 1957 | 97 | 20 |
| 1958 | 82 | 19 |

In many cases the same species of insects showed up year after year in the same premises. Table I shows that the most widespread insects were: the Australian spider beetle, *Ptinus ocellus* Brown (*P. tectus*); yellow mealworm, *Tenebrio molitor* L.; black carpet beetle, *Attagenus piceus* (Oliv.); and the granary weevil, *Sitophilus granarius* (L.). Other insects of prime actual or potential importance under all B.C. conditions are: cadelle, white-marked spider beetle, saw-toothed

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grain beetle, confused flour beetle, Mediterranean flour moth, Indian meal moth, meal moth, brown house moth, white-shouldered house moth. These insects are not necessarily widespread in the province, but when found are usually in large numbers and are capable of rapid build-up. Frequent treatment is required to keep the numbers down.

Pests of lesser importance in the province, with the possibility of serious outbreaks, are: drug store beetle, rusty grain beetle, varied carpet beetle, larder beetle, hide beetle, black flour beetle, broad-horned flour beetle, tobacco moth, *Aphomia gularis* (Zell.), booklouse, grain psocid, grain mites.

A third group follows, of local importance by reason of comparatively low reproductive rate, unsuitable climate or restricted food range: rice weevil, carpet beetle, *Trogoderma simplex* Jayne, fungus beetle, bean weevil, *Pseudeurostus hilleri* (Reit.), golden spider beetle, hairy spider beetle, globular spider beetle, Angoumois grain moth, European grain moth.

The numerous occurrences recorded at Vancouver and Victoria reflect the size and diversity of the food industry in these cities. Most of the species listed are cosmopolitan, but some (*e.g., P. ocellus*), though widely distributed, are confined to the temperate regions of the world. The table gives no indication of the intensity of the infestations, since consideraitons of time and travel did not permit quantitative assessments. These are

**TABLE I.—Distribution of stored food insects by towns and cities in British Columbia, from 1952 to 1958**

| | | |
|---|---|---|
| COLEOPTERA | | |
| Anobiidae | *Stegobium paniceum* (L.) | drug-store beetle |
| Cucujidae | *Cryptolestes ferrugineus* (Steph.) | rusty grain beetle |
| Curculionidae | *Sitophilus granarius* (L) | granary weevil |
| | *S. oryza* (L.) | rice weevil |
| Dermestidae | *Anthrenus verbasci* (L.) | varied carpet beetle |
| | *A. scrophulariae* (L.) | carpet beetle |
| | *Attagenus piceus* (Oliv.) | black carpet beetle |
| | *Dermestes lardarius* L. | larder beetle |
| | *D. maculatus* Deg. | hide beetle |
| | *Trogoderma simplex* Jayne | |
| Mycetophagidae | *Mycetophagus quadriguttatus* Mull. | fungus beetle |
| Mylabridae | *Acanthoscelides obtectus* (Say) | bean weevil |
| Ostomatidae | *Tenebroides mauritanicus* (L.) | cadelle |
| Ptinidae | *Pseudeurostus hilleri* (Reit.) | |
| | *Niptus hololeucus* (Fald.) | golden spider beetle |
| | *Ptinus fur* L. | white-marked spider beetle |
| | *P. ocellus* Brown | Australian spider beetle |
| | *P. villiger* (Reit.) | hairy spider beetle |
| | *Trigonogenius globulus* Solier | globular spider beetle |
| Silvanidae | *Oryzaephilus surinamensis* (L.) | saw-toothed grain beetle |
| Tenebrionidae | *Tenebrio molitor* L. | yellow mealworm |
| | *Tribolium confusum* Duv. | confused flour beetle |
| | *T. destructor* Uytt. | black flour beetle |
| | *Gnathocerus cornutus* (F.) | broad-horned flour beetle |
| LEPIDOPTERA | | |
| Phycitidae | *Anagasta kuehniella* (Zell.) | Mediterranean flour moth |
| | *Ephestia elutella* (Hbn.) | tobacco moth |
| | *Plodia interpunctella* (Hbn.) | Indian meal moth |
| Pyralididae | *Aphomia gularis* (Zell.) | |
| | *Pyralis farinalis* (L.) | meal moth |
| Oecophoridae | *Hofmannophila pseudospretella* (Staint.) | brown house moth |
| | *Endrosis sarcitrella* (L.) | white-shouldered house moth |
| Gelechiidae | *Sitotroga cerealella* (Oliv.) | Angoumois grain moth |
| Tineidae | *Nemapogon granella* (L.) | European grain moth |
| PSOCOPTERA | | |
| Liposcelidae | *Liposcelis divinatorius* (Mull.) | booklouse |
| Atropidae | *Lipinotus patruelis* Pearman | grain psocid |

not necessarily the only occurrences but it is probable that there are no others, for they would otherwise have been detected either in the inspections or by being brought to the attention of the laboratory by management of the firms.

The volume of international commercial traffic into west coast ports will undoubtedly result in other pests becoming established in the province. An example of a recent successful introduction is the Pyralid, *Aphomia gularis* (Zell.), which was recorded for the first time in Western Canada in 1952 in a bakery supply house in Vancouver. It has since spread by commerce to flour and feed warehouses on Vancouver Island. The merchant grain beetle, *Oryzaephilus mercator* (Fauv.), is very frequently intercepted by Plant Inspection Officers in imported cargoes, but it is not yet established.

Inquiry is sometimes made regarding the khapra beetle, *Trogoderma granarium* Everts. This pest of major economic importance is now well

| Mainline-Cariboo | | | | Boundary-Kootenay | | | | | | Okanagan Valley | | | | | | Vancouver Island | | | | | | Lower Mainland | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salmon Arm | Quesnel | Prince George | Kamloops | Trail | Rossland | Nelson | Grand Forks | Creston | Cranbrook | Vernon | Penticton | Osoyoos | Oliver | Kelowna | Armstrong | Victoria | Port Alberni | Parksville | Nanaimo | Duncan | Courtenay | Vancouver | N. Westminster | Mission | L. Prairie | Haney | Chilliwack |
| | | | | | | | | | | | | | | x | | | | x | x | | | x | | | | | |
| | | | | | | | | | | | | | | | | x | | | | | | x | | | | | |
| x | x | | x | | | x | x | x | | x | | | x | | x | x | x | x | | x | x | x | x | x | | | x |
| | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| | | | | | | | | | | | | | | | | x | | x | | | | x | x | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | x | | x | |
| x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | | x | | | | | |
| | x | x | x | | | | x | x | x | | x | | | | x | | | x | x | | x | x | x | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | x | | | | |
| | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | x | | | | x | |
| | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| | | | | | | x | | | | | x | | | x | | | x | x | x | x | x | x | x | x | | | |
| | | | | | | | | | | | | | | | | x | | | | | | x | | | | | |
| | | | | | | x | | | | | | | | | | x | | | | | | x | | | | | |
| | | | x | | | | | x | | | | | | x | | | | | | | | x | x | | | | x |
| x | | x | x | | | x | x | x | | x | x | | | x | x | x | x | x | x | x | x | x | x | x | x | | x |
| | x | | x | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | x | | | | | | x | | | | | |
| | | | | | | | | | | | | | | | | x | | | | | x | x | | | | | |
| x | x | x | x | | | x | x | x | x | x | x | | | x | x | x | | x | | x | x | x | x | x | x | | x |
| | x | | | | | | | | | x | | x | x | | | x | | x | x | | x | x | x | | | | |
| | | | | | | | | | | | | | | | | x | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | x | | x | | | | x | | | | | |
| | | | | | | x | x | x | | x | x | | | x | | x | x | x | x | x | x | x | x | x | x | | x |
| | | | | | | | | | | | | | | | | | | | | | | x | x | | | | x |
| | | | x | x | | x | | | x | x | x | | | x | | x | | | x | | | x | | | | | |
| | | | | | | | | | | | | | | | | x | | | x | x | | x | | | | x | |
| | | | x | | | | x | x | | | x | | | x | x | x | | | x | | | x | | | | | |
| | | | x | | | x | | | | x | x | | | x | x | x | x | | x | x | x | x | x | x | x | | x |
| | | | x | | | x | | | | | x | | | x | | x | x | | x | x | | x | x | | | | |
| | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| | | | | | | x | | x | | | | | | | | | | | | | | x | | | | | |
| | | | | | | | | | | | | | | | | x | | | | | | x | x | | | | |
| | | | | | | | | | | | | | | | | x | | | | | | x | x | | | | |

established in the south-western U.S. It has not yet appeared in B.C. nor is it likely to become established because the climate is unsuitable (Howe and Lindgren 1957).

Acarina are of economic importance at the coast, especially *Acarus siro* L. However, mites are not included in this list since they are seldom important away from the coast, and because they cannot be recognized on sight.

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## The Collection of Coleoptera in the Department of Zoology, University of British Columbia

When I arrived at this University in the Autumn of 1924, I set out to build three collections of insects: first, a systematic collection representing all Orders occurring in the province; second, a synoptic collection for teaching; and third, a demonstration collection of insects of economic importance. It soon became evident that the systematic collection was the first essential, so skeleton collections only were made for teaching and of economic insects, and I concentrated on taking every insect of nearly every Order that I came across every Saturday afternoon and Sunday during summer months or whenever else I found them throughout the year.

At that time there were available in the Province, for reference, the Hopping collection of Coleoptera and the Buckell collection of Orthoptera at Vernon, the Blackmore collection of Lepidoptera and the Downes collection of Hemiptera-Homoptera in Victoria and the Glendenning collection of aphids at Agassiz. So I took no Lepidoptera, but concentrated on the smaller Orders, collecting only those beetles and bugs that I happened to find without actually hunting for them.

The late Kenneth Auden, a student in his fourth year in 1924, was a very keen coleopterist and gave me what he called "trash", namely duplicates of a few common species of which he had large series and these constituted the beginning of the beetle collection.

In time I had accumulated some 26 Schmitt boxes of beetles so that when Mr. George Hopping was loaned to the University by the Federal Government in the winter of 1945-46 to lecture in forest entomology, he spent seven months arranging the beetles into two 18-drawer cabinets and one cabinet of duplicates. He also added some specimens from his father's collection to fill conspicuous gaps in the University collection, chiefly of representative species from outside this province.

Meanwhile I kept on collecting. In the post-Hopping years, much of the material was identified by Professor M. H. Hatch of the University of Washington, Seattle, and more latterly by Mr. Gordon Stace-Smith of Creston who probably has the most extensive collection of B.C. beetles extant.

To these three specialists I owe a great debt of gratitude and offer my sincerest thanks.

No one, however, has been a better entomological friend to our University than Hugh B. Leech, formerly of the Division of Forest Insects, Vernon, but now in charge of the immense collection of Coleoptera at the California Academy of Sciences, San

Francisco. Mr. Leech not only named any beetles I sent him, but ever since his student days at this University, has given me insects of many Orders for our collections. In the one year that he was a student here in 1956-57, Hugh's son Robin carried on in his father's beetling footsteps. We owe a great deal to this father and son team and acknowledge it with pleasure and gratitude.

Many students also, over the years, have given us specimens we lacked or those of which we had very small series.

On 11 March, 1952 the beetle collection was counted by five senior students in Entomology and again on 18 October, 1957 by Michael J. Daniels, a graduate student in Zoology: the totals are shown below.

| | March 1952 | October 1957 |
|---|---|---|
| Number of families | | 80 |
| Total specimens | 24484 | 30616 |
| Duplicates only | 10084 | 10231 |
| No. of B. C. species | 1138 | 1538 |
| Total species | 1864* | 2211 |

* Errors, omissions and additions excepted.

The gain in five and one half years is exactly 400 species and 6132 specimens, a pleasing total. There is still a long way to go to catch up to Mr. Gordon Stace-Smith who has over 2400 B.C. species and an unknown number of specimens. On the other hand, considering that there was not ONE SINGLE beetle here when I arrived, these totals are gratifying especially when one considers the other orders I have assembled, *e.g.*, some 6000 specimens each of Hymenoptera and Hemiptera, about 4000 Orthoptera, 12000 Diptera and minor Orders in proportion.

These figures emphasize what I have pointed out repeatedly, namely, that British Columbia is an entomologist's paradise.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# TRITHION AS AN ORCHARD INSECTICIDE[1]

D. P. Pielou and R. S. Downing[2]

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Trithion[3], formerly known as Compound R-1303, is the brand name of a material containing *O, O*-diethyl *S*-(*p*-chlorophenylthiomethyl) phosphorodithioate (Stauffer Chemical Company, 1956).

This paper is a summary of the main, or typical, findings of experiments that we carried out with Trithion in the Okanagan Valley of British Columbia from 1955 to 1957. Though otherwise excellent, this material has a shortcoming indicated herein, that precludes its recommendation for use in British Columbia orchards.

Trithion has been available as a 25 per cent (by weight) wettable powder and as a "flowable" material, an aqueous emulsion containing 4 pounds of the technical chemical per U.S. gallon. We do not know the nature of the so-called inert materials in either formulation.

The compound interested us as a general insecticide comparable with Diazinon [*O, O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate] in having "wide-spectrum" effectiveness against several groups of orchard insects and mites (Pielou and Proverbs, 1958) and was compared directly with Diazinon in many of our orchard trials.

## Method of Application and Deposits on Leaves

The material was applied in two ways. First, large blocks of trees were sprayed with a standard air-blast concentrate machine moving at one mile per hour and applying 75 gallons of liquid per acre. This amount, in a mature orchard, gives full foliar coverage with practically no leaf-drip. With this method the insecticide was usually applied at 8 pounds of 25 per cent wettable powder per acre (concentration of active ingredient in

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water in the sprayer tank, approximately 0.27 per cent by weight). Secondly, the insecticide was applied as a high-volume, dilute spray with a gun machine, or, to small trees, with a hand-operated barrel sprayer. In either case spray was applied until all leaves were dripping. Normal dilutions were one or two pounds of 25 per cent wettable powder or equivalent emulsion in 100 gallons of water (concentration of active ingredient in water approximately 0.025 and 0.05 per cent by weight respectively).

Chemical analysis of leaves immediately after the spray had dried showed that concentrate application at the standard 8-pound rate results in deposits averaging 3.05 micrograms Trithion per square centimetre. Dilute application at the one- and two-pound rates gave deposits averaging 2.33 and 5.70 micrograms per square centimetre respectively (Pielou and K. Williams, unpublished observations).

### Control of the Codling Moth

The codling moth, *Carpocapsa pomonella* (L.), is the most serious apple pest in British Columbia. For a number of years it has been assumed that control of this species could only be attained if there is a persistent deposit, above a certain minimum value, of a suitable insecticide on leaves and apples during the period of emergence and oviposition of the first brood (approximately from the end of May to the end of June) and, sometimes of the second brood (approximately the first two weeks in August). DDT has been a standard material (Marshall, 1953) for such "cover" sprays in British Columbia for the last twelve years and is used as a reference material in testing new insecticides. Though DDT is satisfactory the possibility of the appearance of DDT-resistant strains of the codling moth in British Columbia warrants search for new insecticides.

In 1956, plots in an orchard of Red Delicious apples were treated with four cover sprays on May 25, June 11 and 27, and July 30. Application was made with an efficient air-blast concentrate sprayer travelling at one mile per hour. The materials compared were 50 per cent DDT wettable powder at 6 pounds per acre (*i.e.* 3 pounds active material) and 25 per cent Trithion wettable powder at 9 pounds per acre (*i.e.* 2¼ pounds active material). No sign of spray injury was seen though the residue of Trithion had a rather objectionable, spotty appearance. At harvest, 500 apples were picked from each of five trees for each treatment. The percentages of wormy fruit for the treatments were: DDT, 10.7; Trithion, 9.0. The corresponding percentages for "stings" (unsuccessful larval attacks) were 3.3 and 2.2. The difference is not statistically significant in either case.

In 1957 the experiment was repeated on Red Delicious, Golden Delicious and McIntosh apples. The layout of the orchards did not permit randomization of varieties, so comparisons are only possible between the two materials within varieties. On Red Delicious at harvest the percentages of wormy fruit for the treatments were: DDT, 6.6; Trithion, 10.8. On Golden Delicious: DDT, 12.5; Trithion, 17.5. On McIntosh: DDT, 8.4; Trithion, 7.7. These would be high figures in commercial control but we deliberately choose heavily infested orchards, so initial population was high. None of the differences are statistically significant. Trithion appears, therefore, as equal to DDT for control of the codling moth.

Considerable foliar damage occurred with Trithion in 1957; this is referred to later.

### Control of the Eye-Spotted Bud Moth

The larva of the eye-spotted bud moth, *Spilonota ocellana* (D. & S.), does not damage the fruit in the serious way that the codling moth larva does, but the superficial injury is a blemish, which, with the present premium on surface finish, downgrades the fruit. In the 1956 trials against the codling moth, the eye-spotted bud moth was also common in the experimental plots.

Bud moth injury affected only 1.0 per cent of the fruit in the Trithion plots but was 10.2 per cent on the DDT plots. In another experiment an infestation of bud moth on cherry was totally destroyed with Trithion.

## Control of the Apple Aphid

We have compared Trithion with other aphicides for the three years that trials have been in progress. Malathion [*S*-(1, 2-dicarbethoxyethyl)-*O, O*-dimethyl phosphorothithioate] has been used as the reference material because it is the recommended aphicide for British Columbia. The apple aphid, *Aphis pomi* DeG., has become, after the codling moth, the most serious pest of apple in British Columbia.

The state of affairs, and the effectiveness of Trithion, may be illustrated by the following examples:

1. A good commercial orchard of McIntosh and Red Delicious apples under sprinkler irrigation and with permanent grass cover crop was moderately infested with aphids. The trees in this orchard were up to 18 feet high, well pruned, at the peak of production, and not overfertilized. Separate plots of 17 to 23 trees each were sprayed in late July with Trithion and Malathion emulsions. Application was at the rate of 4 pounds of active ingredient per acre, with an air-blast concentrate sprayer applying 75 gallons of liquid per acre. On three occasions after application ten terminal twigs were cut at random from each of ten trees for each treatment. As apple aphids tend to congregate on the uppermost leaves of a twig, the five terminal leaves on each twig were closely examined for living aphids. In all, 500 leaves per treatment were examined on each occasion. Results are shown in Table I where the figures indicate total aphids per 500 leaves. It will be seen from the table that re-infestation was almost complete within three weeks. Trithion and malathion were approximately equally effective.

**TABLE I**

| Days after application | 4 | 10 | 20 |
|---|---|---|---|
| Trithion plots | 3 | 21 | 161 |
| Malathion plots | 6 | 30 | 198 |
| Untreated plots | 320 | 282 | 265 |

2. When five-year-old Red Delicious trees, growing very vigorously, were sprayed with the two materials at the same rates, somewhat different results were obtained. These trees had, initially, a much heavier infestation (over 100 aphids on some leaves) than those in the preceding example. Three days after application almost complete kill was noted on exposed, uncurled leaves with both materials. When the young leaves of the growing points of twigs were unfolded, however, eight survivors were found per terminal with the malathion treatment and three for the Trithion treatment. In view of the many small branches that were involved, this meant a considerable total of living aphids on each tree. Considering the great reproductive potential of the apple aphid these constituted a ready source of infestation. The difference with the two materials is just statistically significant.

3. We have carried out extensive experiments on dwarf apple trees (growing on Malling IX dwarfing rootstock). On these trees insecticide was applied as a conventional, dilute spray at 0.5 pounds of active ingredient per 100 gallons. These experiments, as a whole, showed that Trithion was significantly better against the apple aphid than malathion: On these well-growing, much branched and well-fertilized small trees, survival of aphids on uncurled leaves after treatment with malathion was approximately five per cent on the average. On such leaves complete mortality was nearly always achieved with Trithion. However, when the tightly curled

young leaves at the tips of the terminals were examined, survivors were found with both materials. The percentage of survivors varied in different experiments but there were significantly fewer with Trithion in nearly every case.

At this point it is noteworthy that other work at the Summerland laboratory (Pielou and K. Williams, unpublished) showed that although Trithion has a persistent residue, chemically detectable after three weeks, the residue is ineffective in preventing reinfestation by the apple aphid. This is because the fall-off in deposit, to a level insufficient to affect aphids, is very rapid in the first three days. However, the small residual deposit appears to be effective against the European red mite, *Metatetranychus ulmi* (Koch), about two weeks after application (Downing, 1958).

Only a few years ago, fruit growers applied special spray treatment to control the apple aphid; at most, a single application per season of one of the older aphicides such as nicotine kept this aphid at a subeconomic level. However, in recent years infestations have increased, and they have persisted for a longer part of the season. Several applications of aphicides have often been necessary and there have been many complaints from growers that malathion was ineffective and some contention that the insect had developed strains resistant to this material. However, we have no evidence for development of strains resistant to malathion and our experience suggests an alternative hypothesis. As indicated above, where mature, reasonably fertilized trees with not much succulent new growth, have been sprayed with malathion we have achieved almost perfect control, as we have done also with newer organic phosphate materials. Admittedly, reinfestation by winged aphids from other sources has often taken place within two to four weeks. However, when malathion has been applied to young, vigorously growing trees with plenty of succulent growth arising from plentiful watering and nitrogenous fertilizer, we have not achieved satisfactory control. Such trees are apt to support a very high population of the apple aphid; these aphids have a strong preference for the terminal growing tips of the twigs. There, large numbers of aphids cause leaf curling and consequently are well protected; although malathion destroys nearly all aphids on exposed leaves there are always a considerable number of survivors in the curled terminal leaves. Better results were achieved with Trithion but perfect control was rare.

Apart from the mechanical protection afforded by curled leaves, together with the very high populations that offer a greater chance for some survival, the experiments described above suggest that aphids on such young, vigorous trees are more difficult to kill than those on mature trees. Aphids surviving on such trees provide a source of reinfestation for all trees.

Changes in cultural practices in the last decade, rather than destruction of predators by DDT, seem to have brought about the overall increase in apple aphid populations. Use of high-nitrogen fertilizers, such as ammonium nitrate, has increased without any reduction in the total quantity of fertilizer applied per acre. And there has been a change from furrow irrigation to sprinkler irrigation with consequent greater use of water. Along with the change to sprinkler irrigation clean cultivation has been abandoned in favour of permanent or semi-permanent cover crops. The vigorous, succulent growth induced in trees, especially young trees, and the general increase in moisture and humidity appear to have created ideal conditions for what can only be described as the culture of aphids in orchards. This is the most probable explanation of present high aphid populations, of the ready reinfestation after control and of the impossibility of achieving seasonal control with a single application of any of the current insecticides.

### Control of Other Aphids

Trithion at two pounds of 25 per cent wettable powder per 100 gallons applied with a high-volume sprayer gave almost perfect control of the thistle aphid, *Anuraphis cardui* (L.), on prunes and of the mealy plum aphid, *Hyalopterus pruni* (Geof.) (=*H. arundinis* (F.)), on prunes and apricots. After a single application in the summer it was difficult to find any living aphids. Reinfestation with either of these species is generally not a problem if the entire orchard is sprayed. The mealy plum aphid on old apricot trees over 20 feet high was also effectively controlled by a single application of Trithion, at eight pounds of 25 per cent wettable powder per acre, with a concentrate sprayer.

Because of the lack of infestations only a few tests were carried out on the black cherry aphid, *Myzus cerasi* (F.) and these were on very small trees. At two pounds of 25 per cent wettable powder per 100 gallons 100 per cent mortality was achieved. A difficulty in controlling the black cherry aphid is that cherry foliage is particularly susceptible to injury from malathion and there are objections to other common aphicides (Pielou and Proverbs, 1958). Trithion caused some foliar damage (vide infra) but less than malathion. However, Diazinon, the material now recommended, is practically harmless to cherry foliage (Pielou and Proverbs, 1958).

We have not done any work with the green peach aphid, *Myzus persicae* (Sulz.), an occasionally troublesome pest of peaches. This aphid has been present only at a low level in the Okanagan Valley in the last three years. However, experiments elsewhere suggest that Trithion gives only indifferent control of this aphid.

### Control of Lecanium Scales

Scale insects of the genus *lecanium* have become a serious problem on peaches and apricots in the Okanagan Valley in the last few years. Trithion applied in the dormant stage at 2.4 pounds of 25 per cent wettable powder, as a dilute spray from a handgun machine controlled these insects. But application four weeks later, when the buds were showing pink, was less effective. Malathion application at the latter date and rate was decidedly inferior to Trithion. However, Trithion, at this stage of plant development, was inferior to Sevin [N-methyl-1-naphthyl carbamate; Union Carbide Chemical Company, White Plains, N.Y.] which gave excellent results. In July the average numbers of surviving scales per 50 leaves were: Sevin, 64; Trithion, 228; malathion, 349; untreated, 1580.

### Control of the European Red Mite

Some data have been recorded on the effect of Trithion on the European red mite, *Metatetranychus ulmi* (Koch), in comparison with other materials (Downing, 1958). Trithion, when applied at the pink-bud stage, gave good control of the mite on apple. After application by air-blast concentrate sprayer at the rather high rate of 16 pounds of 25 per cent wettable powder per acre on Red Delicious trees in early May, the density of mites was 0.10 per leaf in early June and 0.81 per leaf in early August. Comparable figures on plots that received no treatment were 0.27 and 19.8 per leaf.

As a summer spray, Trithion was also effective. Trithion was applied to Winesap apples in mid-July at the rate just mentioned. At the end of July the average number of mites was 1.74 per leaf; by mid-August, 0.46 per leaf. The comparable figure on untreated trees was 21.8 per leaf by the end of July, the population being so high that these control trees had to be sprayed to satisfy the grower.

### Control of Brown Mite

Trithion, applied as a dilute spray in summer at one pound of 25 per cent wettable powder per 100 gallons, reduced populations of the brown mite, *Bryobia arborea* M. & A. from 21.6 per leaf of 8.6 in ten days and to zero in six weeks. The comparable figures on untreated trees were 22.0, 5.6 and 13.4. Trithion was also significantly superior to the specific miticide, sulphenone [*p*-chlorophenyl phenyl sulphone; Stauffer Chemical Company, Mountain View, California] recommended for the brown mite in British Columbia.

### Control of the McDaniel Spider Mite

Application of Trithion by air-blast concentrate sprayer in summer at the somewhat high rate of 12 pounds of 25 per cent wettable powder per acre reduced the number of the McDaniel spider mite, *Tetranychus mcdanieli* McG., to an average of 1.6 per leaf in eight days and to 1.2 per leaf in 21 days. With application at eight pounds per acre the figures were 4.6 and 2.7. The comparable figures for untreated trees were 24.2 and 25.4. Control of the McDaniel mite with Trithion was as good as with the miticides now recommended.

### Control of the Apple Rust Mite

The apple rust mite, *Vasates schlechtendali* (Nal.) has been controlled with Trithion. On Italian prunes, application of a dilute spray with a gun-type machine reduced the number of mites from 203 to less than one per leaf in 26 days. As the rust mite is much smaller than those previously mentioned, this reduction in numbers is regarded as evidence of adequate control. On untreated trees in this experiment there was some reduction from natural causes, but there were still 64 rust mites per leaf after 26 days.

Trithion was ineffective against another common eriophyid, the pear leaf blister mite, *Eriophyes pyri* (Pgst.).

### Phytotoxicity

Although in 1955 and 1956 Trithion had produced no signs of leaf or fruit damage when applied either as dilute or concentrate sprays, in 1957 damage from this material was evident in several orchards. On Golden Delicious apple the damage was particularly bad. Two weeks after the second cover spray, yellowing and necrosis of many leaves were apparent and defoliation was beginning; another two weeks later, defoliation was extensive. In some plots, further application of Trithion had to be discontinued for fear of total defoliation. At harvest time, the apples showed some russetting and were smaller than those from trees that had been sprayed with DDT. On Red Delicious, there was no serious defoliation but the leaves showed numerous purple spots that later became necrotic. Up to 50 per cent of the leaf area was affected in this way. McIntosh foliage showed least injury although some leaf spotting was eviden in the lower branches.

Some yellowing of leaves and slight defoliation were evident on apricot and cherry trees to which dilute sprays of Trithion had been applied. Severe defoliation of cherry occurred after application of concentrate spray as a drench. Trithion also caused some yellowing of the foliage of strawberries, ornamentals, and certain vegetables.

Both wettable powder and emulsion formulations of Trithion caused injury in 1957. It was first thought that the damage might have been due to a change in formulation. Tests of phytotoxicity therefore were carried out with some of the material supplied in 1956. Again, serious leaf spotting and defoliation were apparent, particularly on the variety Golden Delicious. It seems probable, therefore, that the technical material itself is responsible for the damage and that growing conditions (1957 was a late season with cool summer) were particularly favourable for damage. Alternately, perhaps, climate conditions favoured weathering of Trithion to some particularly phytotoxic breakdown product in 1957. In any case, in view of the importance of the varieties, Red Delicious and McIntosh, and the rapid increase in plantings of Golden Delicious, we considered that Trithion, in spite of its great insecticidal potency and the fact that it caused damage only in one year out of three, could not be recommended to the growers. Moreover, there are reports of damage in Trithion trials from Washington State (Anthon, 1958) and from Australia (G. Miller, Tasmania Dept. of Agriculture, private communication).

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## ERADICATION PROCEDURES FOR ORIENTAL FRUIT MOTH IN THE OKANAGAN VALLEY OF BRITISH COLUMBIA

W. D. Touzeau[1] and C. L. Neilson[2]

In 1957 plans were outlined for the eradication of a potential infestation of oriental fruit moth in the Southern Okanagan Valley (1). It is now intended to report on what was done and the results as noted to date.

In the fall of 1956 the ripening rooms of the two canneries involved were fumigated with methyl bromide. This served as an immediate check on the most probable locations of infestation as the fruit had been placed in these rooms on arrival and before going into cold storage until processed.

Extensive organization by federal and provincial authorities resulted in an early spring and summer program of insect elimination. This included cannery fumigation, removal of trees and fumigation of the orchard land where possible infested fruit waste had been scattered, fumigation of other waste dump areas, spraying of orchards adjacent to canneries and compensation for any losses, and trapping for possible recovery of adult oriental fruit moths throughout the Southern Okanagan Valley.

Early in the year fumigation matters were attended to and a deadline date of April 6, 1957, was set. After contracting for the fumigation of the canneries and certain land areas, it was necessary to assemble a great deal of material, including electric gas analyzers, polyethylene tubing, thermometers, leak detectors, test insects, cages, extension cords, etc. A mobile laboratory was obtained to house the gas analysis equipment. The fumigators, Columbia Pest Control, Ontario, California, supplied their own tarpaulins to cover the areas and, on March 13th, started to cover the cannery of York Farms, Osoyoos. This was completed in one day. The area fumigated was 333,015 cubic feet. In this same vicinity it was required to fumigate a junk pile of 11,000 cubic feet, settling pits of 13,000 cubic feet, and a fruit refuse dump area of 4,500 cubic feet.

On March 18th the operators moved to Barkwill Cannery at West Summerland. The area involved in the cannery fumigation was 298,000 cubic feet, an adjacent hillside 10,000 cubic feet, the orchard area 423,600 cubic feet, with a re-fumigation of 16,800

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cubic feet. A grand total of 1,109,915 cubic feet was fumigated. In all cases the initial dosage was at the rate of 5 lbs. methyl bromide per 1,000 cubic feet.

Prior to the fumigation of the orchard land the trees had been removed to one foot stumps, the trees being burned. In order to support the tarpaulins for the land fumigation, apple boxes were placed between the tree stumps to allow better circulation of the gas. Over 4,000 boxes were used and these had to be moved as each section was treated. The entire orchard was treated in 27 sections, ranging in size from 4,000 square feet to 38,000 square feet, with the average approximately 15,000 square feet. The initial dosage in all cases was at the rate of 5 lbs. methyl bromide per 1,000 cubic feet. Due to the tremendous soil sorption, especially in gravelly sections, the average amount of methyl bromide required was approximately 23 lbs. per 1,000 cubic feet.

The steep hillside adjacent to the cannery posed another problem in supporting the tarpaulins. This was solved by constructing a framework of 2 x 4's attached to stakes driven into the ground. The desired concentration of gas was maintained with 13 lbs. of fumigant per 1,000 cubic feet, with fan circulation.

The final fumigation was completed on April 10th, which was considered satisfactory for the project.

Following fumigation all roadways, parking areas and areas immediately adjacent to both canneries were thoroughly sprayed with diesel oil plus 25% emulsifiable DDT, 4 lbs. actual per 100 gallons of oil.

A spray program had been outlined for orchards adjacent to the canneries, as a follow-up of the fumigation. In order to be able to maintain an efficient and steady spray schedule a concentrate sprayer was purchased, to be operated under the supervision of the Entomology Laboratory at Summerland. Some seven acres of orchard were sprayed in the vicinity of the Osoyoos cannery, whereas thirty odd acres were sprayed adjoining the Summerland cannery. All varieties of fruits within these acreages were sprayed, using 50 gallons of spray per acre.

The spray period for Osoyoos was April 25 to May 10/13 for apricots, and April 18 to June 21/25 for peaches and other fruits. In Summerland the spraying extended from April 29 to May 23/24 for apricots and other fruits, and from April 26 to June 26/29 for peaches. The Osoyoos apricots received three applications of DDT 50% wettable powder, 12 lbs. per acre, Colloidal Spray Modifier 1 pint per acre. Four similar applications were given to apricots in Summerland. The peach spraying started at the rate of 12 lbs. per acre but was reduced to 6 lbs. later in the season because of the residue problem. In Osoyoos 5 applications were made at the higher rate and 2 at the lower, whereas in Summerland 4 applications were made at 12 lbs. and 3 at 6 lbs. Average figures on spray residue have been provided as DDT parts per million of fruit. The legal tolerance is 7ppm. By harvest time the residue problem on peaches and apricots was of very little concern.

Special problems in arriving at grower loss and fruit compensation values were encountered. Cherry yields and grades had to be estimated on the trees as the fruit was not harvested, due to excessive spray residue. Some spray damage occurred on apricots. The amount of damage due to reduced size of fruit, excess fruit drop, and fruit burn were factors which had to be considered and reconciled so that the growers could be equitably compensated.

A trapping program was initiated to determine if oriental fruit moth had become established in the peach-growing sections of the South Okanagan Valley. Traps were set in a circumference of a mile from the fumigated canneries and in several

| Fruit | Location | Last Spray | Residue on | | Residue at harvest on | |
|---|---|---|---|---|---|---|
| Peach | Summerland | June 29 | June 29 | (36 ppm) | Aug. 13 | (3.6 ppm) |
| Peach | Osoyoos | June 21 | June 24 | (22 ppm) | Aug. 27 | (3.1 ppm) |
| Apricot | Summerland | May 24 | June 29 | (48 ppm) | July 24 | (8.5 ppm) |
| Apricot | Osoyoos | May 10 | June 24 | (6.6 ppm.) | | — |

other strategic points throughout the Valley, from the international boundary to Summerland and into Naramata, Westbank and Kelowna. Four hundred and twenty-four traps were used. Throughout the season 9,231 trap inspections were made, using 1,360 gallons of bait which was prepared in batches of 45 gallons, using 2 gallons panomalt, 160 lbs. golden brown sugar, .5 lb. Brewer's yeast, and 42 gallons water. Two suspicious moths were found but neither proved to be oriental fruit moth.

Fruit fumigation trials were conducted at the London Laboratory, to determine the lethal dosage of the various stages of the insect, as well as the tolerance of the fruit. Modifications were made in the import regulations. Fumigation is now required only for the fruits of apricot, peach, pear, and quince.

Late season observations on the fumigated land indicated that there had been considerable killing of weed seeds, and the couch grass had been completely killed out in the entire orchard. Fruit trees which had been replanted showed very good growth, better than usual with freshly planted nursery stock.

### Cost Estimates

| | |
|---|---|
| Fumigation — including consultant fees, fumigation contract, gas, salaries, travelling expenses, extra labour | $ 43,843.00 |
| Spraying — including sprayer, material, wages, labour | 8,057.25 |
| Trapping — including material, salaries, travelling expenses, labour | 5,415.69 |
| Provincial Government — including preliminary fumigations, orchard compensation, fruit compensation, transportation | 17,333.89 |
| | $ 74,649.83 |

## Acknowledgments

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## On the Reproductive Potential of the Sheep Nostril Fly *Oestrus ovis* L. (Diptera: Oestridae)

Most references state that the eggs of the sheep nostril fly hatch in the body of the mother and the fly deposits living larvae; Hearle (1) states that in one instance under observation, 60 larvae were deposited in one hour. Only one reference that I can find, (Smart, (2)) states that the fly deposits eggs.

In 1954 when working on the Lac du Bois cattle ranges some 13 miles from and 2000 feet above Kamloops, I found that newly emerged nostril flies clustered in crevices in the old log hut that was being used as a laboratory, particularly in the holes cut into the door frame to take the latches of the lock. On one morning before the sun warmed the cabin no fewer than four female flies were clustered there; they were freshly emerged and undamaged. There were no sheep on the ranges at this time so the flies may not have been chasing anything.

One of these flies was dissected to determine the egg-laying potential. The ovaries were distended with 624 eggs of uniform size each 0.4 mm. long, which readily separated out from the follicles. Abruptly smaller than this series, were strings of very tiny moniliform ova in the germaria.

It would seem that the flies lay the first quota of 624 eggs and either lay no more or remain quiescent until the second series develops. At the tips of the follicles, in the germaria, were minute embryonic eggs which probably never develop before the fly season ends.

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—*G. J. Spencer, University of British Columbia.*

### A Food Plant of *Orthoris crotchi* Les. (Coleoptera, cruculionidae)

On September 8, 1956, I found pupae of the weevil *Orthoris crotchi* Lec. in the seed pods of stick-leaf, *Mentzelia laevicaulis* T. and G. at Oliver, B.C. More than 100 adults were obtained in the ensuing 5 weeks from dried plants kept at room temperature. A parasite, *Bracon* possibly *nupera* Cress. was identified by Mr. C. D. F. Miller of the Systematics Unit in Ottawa.

On June 14, 1947, adult weevils were literally swarming on stick-leaf plants at Midway, B.C. In spite of its local abundance, this species is apparently rare in collections of B.C. Coleoptera.

—*J. Grant, Forest Biology Laboratory, Vernon, B.C.*

# OBSERVATIONS ON A PINE SHOOT MOTH, *EUCOSMA SONOMANA* KFT. (LEPIDOPTERA: OLETHREUTIDAE)[1]

J. GRANT[2]

The shoot moth, *Eucosma sonomana* Kft., is one of a group of six members of this large genus which Heinrich (1923) lists as feeders on coniferous trees. In British Columbia it is known to occur across the southeastern part of the province from Elko to the Okanagan Valley and northward as far as Chase.

Ponderosa and lodgepole pines are the only hosts so far recorded in British Columbia; larvae have been reared on Englemann spruce in Montana.

The following observations were made in the summer of 1957 in the Grand Forks district, and refer only to attacks on ponderosa pine.

## Life History

The pupa overwinters. It is believed that the egg is laid in early spring on the growing tips of the host tree. Young, open grown stands are most susceptible but trees up to 40 feet in height may be attacked. The larva bores into the centre of the shoot, leaving only a minute trail at first, but in the late instars, hollowing out most of the central pith. During the feeding period there are no exudations of pitch or frass; the only symptoms are a slight dwarfing of infested terminals, and a tendency to droop. When fully grown the larva bores an exit hole through the side of the shoot and drops to the ground.

Larvae from Cascade and Midway pupated in the insectary at Vernon between mid-June and early July. Pupa were kept in the insectary until the autumn, when they were placed in cold storage at 35°F. Adults began to emerge three days after the pupae were transferred to constant temperature cabinets at 70°F.

## Economic Importance

Although *Eucosma sonomana* may seriously disfigure young pines by killing or distorting the new growth, it is not considered to be a pest of major importance in British Columbia. Multiple stems are the most serious deformity resulting from the death of the main leader, but as many of the infested leaders survive, the form of the tree is not always affected.

Three types of injury have been observed. Dead, slightly curved leaders

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and branch terminals are the most conspicuous evidence of infestation; because mortality occurs before growth is completed, the needles of the dead shoots are not fully expanded.

The second type of injury is caused by the breakage at the larval exit hole, of shoots that would otherwise have survived; the third is the distortion of growth of shoots surviving borer attack.

Near Cascade in a sample of 47 ponderosa pine saplings between 4 and 10 feet in height, 40 per cent were infested in 1957, 70 per cent of the infested shoots died after larval emergence, while the remainder suffered varying degrees of deformity.

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# NOTES ON THE LIFE HISTORIES OF THREE SPECIES OF LEPIDOPTERA FROM SOUTHERN VANCOUVER ISLAND, BRITISH COLUMBIA

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Provincial Museum

The following butterfly and two moths do not seem to have had their early stages described in any readily referable publication, if at all. Accordingly, they are submitted in the hope that they will be of interest to students of this group.

### *Speyeria bremnerii* Edw.

A female of this large Nymphalid butterfly, caught in Saanich, was confined over a growing plant of *Viola palustris* on August 11, 1956. By August 19 it had laid between 30 and 40 ova, scattered about the stem and leaves and among the surrounding moss.

The eggs hatched August 31, and after consuming the eggshells, the larvae went into a dormant condition. They basked in the sunshine on warm days, but no further feeding or growth was noted. The 10 in. pot containing the young larvae was placed out of doors under the eave at the south side of the house, where they remained for the rest of the winter.

**Ovum.** Size 1.0 by .60 mm., conic-truncate, coarsely ribbed and cross-ribbed, shiny; dull cream.

**Larva. 1st Instar.** Length 2 mm. Head jet black, shiny. Body drab dirt colour, with a small shiny, black, cervical plate on T.1; rest of body with long, fine, un-branched, black hairs. By March 29, 1957, the whole brood seemed to have hibernated successfully and was commencing to nibble on pansy shoots. By April 9 they were 4-5 mm. long, the colour as before. The caterpillars were gregarious, bunching up in sunny patches when not feeding on the yellow pansy leaves or the violet which was then becoming available.

**2nd Instar.** April 16. Length 5 mm. Head shiny, black. Body black with black branched spines arising from the usual tubercles. They still massed together when not feeding.

**3rd Instar.** April 22. Length 8 mm. Head as before. Body as before but thin greyish subdorsals evident.

**4th Instar.** May 10. Length 10-12 mm. Head black, sparsely short-haired. Body blue-grey due to whitish flecks on a fuscous and ochre background; a black dorsal and a dark longitudinal line connecting the tubercles; tubercles yellowish, most noticeable on the spiracular row. The caterpillars became more independent and did not mass together so much. By May 16 the length varied from

12-18 mm. By May 18 they were feeding ravenously, so that 30 had to be transferred to another flower pot.

**5th Instar.** May 27th. Length 30 mm. Head dull black, pale buff mottlings on sides. Body black faintly freckled with buff. Spines shorter on T.1, bases of shafts black on first two rows, yellowish on rows 3 and 4. A double dorsal line of pale milky white with 2 black spots each side of dorsum of each segment, underside concolorous with the upper, spiracles grey ringed with black. On June 10 the largest were fully fed and 40 mm. long. Some of the smallest, however, were only half this length. The largest specimens pupated on June 11. Several more pupated on June 23 and others were preparing to do so.

**Pupa.** Pupation took place in a slight hollow under a root or loose tuft of grass. The cavity was usually longer than high and was thinly lined with silk. The pupa was attached to the upper side and hung horizontally due to the rigid upward curve of the last three segments. Size 18 by 6 mm. not counting the curve of the last segments; smooth and dull, due to very fine etchings. Colour piceous with ochre or clay-coloured spots and patches on the wing-cases, and a broad band of the same colour on the abdominal segments; spiracles black. Cremaster a closely packed group of short, stout, outwardly curved, hooked hairs on the truncate summit of a thick, rugose extension of the last segment.

**Imago.** Emerged singly over the period from July 2 to August 24, 1957.

### *Aemilia roseata* Wlk.

This fine Arctiid moth has a wing expanse of 33-35 mm. The forewings are a bright brick red freely and evenly spotted with pale yellow clay colour; the hindwings are white tinged with pink. An opportunity to study the life history was afforded by the capture at light in Saanich, of a gravid female which laid more than 20 ova by July 30, 1957. The ova were scattered irregularly in small groups on the sides of the container.

**Ovum.** Size 1.10 by .75 mm. globular with a flattened base, smooth, shiny, with close microscopic punctuation; pale green at first gradually turning to dull grey, showing fine deep-seated spiral lines which were the hairs of the developing larva; a small black dot on the upper surface indicated the position of its head. Hatched August 9.

**Larva. 1st Instar.** Length 3 mm. Head smooth, shiny, pale brown. Body pale glaucous green, covered with long brown hairs. They ate about half of each shell. Fed on Douglas fir.

**2nd Instar.** August 19. Length 7 mm. Head more red-brown than before, covered with short, sparse hairs. Body red-brown between the tufts of reddish hairs. They ate directly into the substance of the needle from any point along its length. When not feeding, the caterpillars rested among the bud-scales at the tip of the shoot, or at full length along a needle. On August 23 a milky-white suffused line along the spiracles became evident with growth; the body very shiny between the tufts of hair, a sign of an approaching moult.

**3rd Instar.** August 31. Length 15 mm. Head as before. A pair of white tufts replaced the red ones on the dorsum of each segment, a pair of long, forward-pointing white hair-pencils on T.1, and a similar pair directed backwards on each of A.8. and A.9.; spiracular line irregular, white, edged with black above; spiracles grey, ringed with black, claspers and underside flesh-coloured. A dark dorsal line was evident by September 7, when the length was 20 mm.

**4th Instar.** September 10. Length 20 to 25 mm. Head shiny, black with labrum white. Body velvet black above with a narrow white girdle at the juncture of the segments, mostly concealed by the tufts of short dense hairs that spread out to meet one another from their individual tubercles; each tuft consisted of hairs of two or three colours, arranged in layers white at the base, then black, and where there were three colours, yellow above and central; along the dorsum were nine pairs of tufts, one pair per segment with a similar, smaller, yellow centred pair below the spiracular line. The rest were black and white; T.1. had a pair of forward pointing white pencils of long hairs, and segments A.8. and A.9. had each a similar pair directed backwards. The admixture of the predominating white and black gave an overall ash colour to the caterpillar, the yellow points breaking up the otherwise solid appearance. Underside light fuscous, legs banded with black and white, zebra fashion, claspers pale dusky. By September 19 they were 30 mm. long. On September 27 the first caterpillar was observed spinning a cocoon among the twigs. Two larvae were still feeding on October 12 but all had spun up a day or two later. The cocoon is regularly oval, smooth and of a close, even texture, grey due to the admixture of the larval hairs.

**Pupa.** Size 15 by 6 mm. Dumpy in appearance, smooth, shiny with no trace of punctuation, mahogany brown. Cremaster, a group of exceedingly fine, short, slightly recurved-tipped hairs on the rounded tip of the last segment.

### *Pseudoglaea olivata* Harv.

This large Phylaenid moth has a wing expanse of 40 mm. The forewings are either olive grey or have a reddish cast, the latter predominating, with darker orbicular and reniform spots outlined with lighter colour and a similar light line across the outer third. A female, taken on sugar in Saanich, September 1956, laid 30 ova between September 4 and 18, scattered over the sides of the box.

**Ovum.** Size .90 by .50 mm. Hemispherical, finely ribbed (about 30) and cross-ribbed, cream coloured turning pink a day later, finally becoming dark brown with an iridescent lustre by late September, remaining thus throughout the winter. Hatched March 12, 1957.

**Larva. 1st Instar.** Larvae emerged through holes in the side of the eggs, but did not eat the shells. Length 3.5 mm. Head large, pale brown. Body semi-translucent, drab, dusky colour with a tinge of purple; tubercles prominent, fleshy, each bearing a short black hair. After trying various plants they fed lightly on *Spiraea discolor* and *Rubus macropetalus.* By March 17 many had died, apparently of starvation. On March 29 *Rubus leucodermis* was tried. This was accepted with avidity and the larvae henceforth thrived.

**2nd Instar.** March 18. Length 4 to 5 mm. Head light brown. Body dull olive, a faint light dorsal, a broad white spiracular, tubercles black each bearing a short black hair, spiracles black; underside honey-colour, cervical plate brown with four white bars.

**3rd Instar.** March 22. Length 6 mm. Growth very slow, possibly because of the wrong food at first. Head light brown. Body fuscous grey with a faint bluish tinge, a distinct white dorsal and thinner subdorsals, spiracular broad, white, edged dorsally with black, otherwise as before; rested at full length along a stem. March 27. Length 9 to 10 mm. Head square, sutures black, a row of small black dots on each side. Body grey-green, dorsal, subdorsals and addorsals white, the last two thinner than the dorsal. Spiracular as before; underside dull greenish fuscous, legs and claspers dark. Fed on *Rubus macropetalus.*

**4th Instar.** March 29. Length 15 mm. Head shiny, pale, translucent green with light brown clouding on the sides. Body fuscous green, otherwise as before. Fed heavily on *Rubus leucodermis.*

**5th Instar.** April 5. Length 20 mm. Head and body as before; general colour fuscous with a greenish tinge, spiracles grey ringed with black. Rested along a stem partly coiled beneath a leaf. April 7. Length about the same. Head as before. Body tinged with pale yellow or olive, dorsal edged with black which is abruptly thickened on each segment, progressively more so towards A.9. Underside whitish thickly etched and flecked with black, tubercles white with black centres, bearing a single minute hair.

**6th Instar.** April 11. Length 20 to 25 mm. Head as before. Body, T.1. shining brown with three white bars, general colour olive, heavily dusted with darker olive, dorsal and subdorsals black-edged, the black edges of the dorsal coalescing at juncture of segments to form a black spot. April 14. Head pale brown, strongly reticulated with fuscous. Body olive, heavily flecked with fuscous, a thin pale dorsal with black blotches on A.1. to 8; spiracular broad, white, sprinkled with greenish fuscous, spiracles white, black-ringed, underside beige, densely flecked with fuscous. T.1. pale brown with two white bars. They were full fed by April 19. Length 40 mm. Dorsal line had vanished, the dark blotches alone remaining. The larvae were very geotropic, evidently seeking a place for transformation. Two of the seven reared to maturity burrowed into the soil for pupation. By May 1 all had spun stout earthen cocoons ready for pupation.

**Pupa.** Size 15 by 6 mm. Smooth, shiny, entirely without punctuation; cremaster, four straight spines arranged in a transverse row, with one or two smaller ones at the base, set on the smooth rounded tip of the last segment.

**Imago.** Four adults emerged about July 28, 1957, the remainder having died in the pupa. The early appearance was probably due to the artificial conditions under which they were reared. The normal period of flight is in August and September.

The 27 specimens in my collection (January, 1958) consist of two colour forms, olive and red, in the proportion, approximately of 16 per cent olive to 84 per cent red, the red predominating in the sexes at about 5 to 1 in the males and 9 to 1 in the females.

## A LIST OF CONE AND SEED INSECTS OF INTERIOR BRITISH COLUMBIA[1]

D. A. Ross[2]

The cone and seed insects listed by host in this article were reared from material collected in the interior of British Columbia during the period 1950 to 1955 inclusive. Most of the cone collections were taken by Forest Biology rangers, and the insects were reared by various members of the Forest Insect Survey at Vernon.

Only specimens identified at least to genus are listed here.

1. Contribution No. 471, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.

| Host | Insect | Locality |
|---|---|---|
| Western white pine, *Pinus monticola* | *Dioryctria abietella* D. & S.<br>*Conophthorus monticolae* Hopk.<br>*Eucosma bobana* Kft. | Trinity Valley, Kaslo, Slocan City, Salmo, Gray Creek, Creston, Balfour. |

| Host | Insect | Locality |
| --- | --- | --- |
| Ponderosa pine, *Pinus ponderosa* | **Dioryctria auranticella* (Grote) | Southern Interior. |
| | *D.* sp. nr. *auranticella* | Southern Interior, less common than *D. auranticella.* |
| | *D. abietella* D. & S. | Southern Interior. |
| | *D. cambiicola* (Dyar) | This twig feeder may occur occasionally in cones in the Okanagan Valley. |
| | **Laspeyresia miscitata* Hein. | Southern Interior. |
| | *L. piperana* (Kearf.) | Grand Forks. |
| | *Corticaria* sp. | Yellow Lake, Grand Forks, Creston. |
| Lodgepole pine, *Pinus contorta* | *Dioryctria abietella* D. & S. | Tagish, Y.T.; Bennett. |
| | *Eucosma* sp. prob. *bobana* Kft. | Fort Fraser. |
| Western larch, *Larix occidentalis* | *Polychrosis piceana* Free. | Syringa Creek. |
| | *Henricus fuscodorsana* Kft. | Sanca Creek. |
| | *Cartodere filum* Aubé | Anarchist Mountain. |
| Black spruce, *Picea mariana* | *Tortrix alberta* McD. | Central Interior, B.C. |
| | *Ernobius nigrans* Fall. | Germansen Landing, Valemount. |
| | *Cartodere filum* Aubé | Vanderhoof. |
| Engelmann and White spruce, *Picea engelmanni* and *P. glauca* | **Laspeyresia youngana* Kft. | Kluane Lake and Whitehorse, Y.T.; Interior B.C. |
| | **Dioryctria abietella* D. & S. | Interior B.C. |
| | *Eupithecia albicapitata* Pack. | Aleza Lake; McNaughton Lake; Woodpecker, Whitehorse, Y.T. |
| | *Polychrosis piceana* Free. | Jaffray. |
| | *Earomyia* sp. | Aleza Lake. |
| | *Cartodere filum* Aubé | Champagne, Y.T.; Fort Nelson. |
| Western hemlock, *Tsuga heterophylla* | *Earomyia* sp. | Aaron Hill. |
| Douglas fir, *Pseudotsuga menziesii* | **Dioryctria abietella* D. & S. | Southern Interior. |
| | *D. reniculella* Grt. (complex) | This foliage feeder may occur in cones occasionally in any part of the Interior. |
| | **Barbara colfaxiana* Kft. | Southern Interior. |
| | *Polychrosis piceana* Free. | Yellow Lake. |
| | *Holcocera immaculella* McD. | Yellow Lake, Pavilion. |
| | *Henricus fuscodorsana* Kft. | Creston. |
| | *Corticaria* sp. | Yellow Lake, Grand Forks. |
| | *Megastigmus spermotrophus* Wachtl | Salmon Valley, Lillooet, Westside. |
| | *Earomyia* sp. | Inonoaklin. |
| | *Sciara pauciseta* Felt (probably secondary) | Hedley. |
| Alpine fir, *Abies lasiocarpa* | *Dioryctria abietella* D. & S. | Hixon, Francois Lake. |
| | *Laspeyresia* sp. | Shelley. |
| | *Megastigmus lasiocarpae* Cros. | Natal, Hixon, Vanderhoof. |
| | *Earomyia* sp. | Prince George. |

* These species are considered to be of considerable economic importance in the interior of British Columbia.

# A BRIEF HISTORY OF THE LARCH SAWFLY, *PRISTIPHORA ERICHSONII* (HTG.), IN BRITISH COLUMBIA[1]

D. H. RUPPEL[2]

The larch sawfly was first noted in British Columbia at Grave Creek, tributary of the Elk River north of Fernie, in 1930, and its occurrence was reported to the Forest Insect Laboratory at Vernon in 1933 (Hopping, *et al* 1943). Since 1933 this insect has spread over the range of western larch, *Larix occidentalis* Nutt., in southeastern British Columbia. In 1952 the larch sawfly was first observed on eastern larch, *Larix laricina* (DuRoi) K. Koch, west of Fort Nelson, and in 1954 it was found on eastern larch at Cluculz Lake and other scattered points southwest of Prince George.

This insect is an important defoliator of larch east of the Rockies, but apparently none of the infestations referred to in the following notes caused any tree mortality. The larch sawfly population in British Columbia had subsided to a very low level in 1957.

## History of Population Trends and Infestations[3]

1930—The larch sawfly was first noted at Grave Creek, a tributary of the Elk River, north of Fernie. It probably was present before this date.

1931-1932—Information is lacking for these years.

1933—The occurrence of the insect in British Columbia was reported to the Vernon Laboratory. The range of Larch sawfly then extended from Sand Creek to Elko and from Elko north in the Elk River Valley to Wright Creek, about 30 miles north of Fernie. Infestations were noted at Fernie and nearby Hartley and Lizard creeks.

1934—The range of the sawfly was not extended. Infestation foci were at Sand Creek, Lizard Creek, Hosmer, Corbin, McGillivray and Grave Creek.

1935—The range of the larch sawfly extended to Roosville, lower Flathead Valley, Yahk River Valley and Glinochi Creek basin immediately north of the Montana border, Gold Creek, Rosin Lake, Bull River, and north to Fairmont Hot Springs which is the northern limit of western larch in the Rocky Mountain Trench.

The insect was also found at Lumberton, where it had probably been active since 1932, and as far west as Kitchener. Infestations were confined to the Elk and Flathead River areas.

1936—Although there was a decided decrease in population levels, the range of the pest extended as far as Boswell on Kootenay Lake.

1937—Numbers of the larch sawfly decreased to a very low level, but the range extended to Slocan Lake.

1938—This year saw a build-up of the insect with infestations at St. Mary's Lake and on the headwaters of Goat River near Kitchener. No extension of range was noted.

1939—The 1938 build-up increased over much of the known range from Fernie to Slocan Lake. Infestations occurred at Kimberley, Moyie Lake, Yahk, Kitchener, Goat River, Creston, and from Boswell to Riondel.

1940—One infestation occurred at New Denver. The insect declined considerably over the remainder of the areas mentioned in 1939, but its range extended to Whatshan Lake.

1941—The larch sawfly spread to the eastern slope of the Monashee Range. The population level was a little higher in most areas but was generally low. Infestations were recorded at New Denver and Summit Lake to the north of Slocan Lake.

1942—The insect was observed for the first time in the Okanagan Valley in the Vernon area, the western limit of western larch. Infestations were noted at Gray Creek, the Kootenay River Valley west of Nelson, Slocan Valley, and from Nakusp to Needles on the Arrow lakes. Defoliation was negligible from Creston eastward.

1943—The only stands of western larch not known to have been infested by the larch sawfly were at Shuswap Lake and in a small area east of Penticton. Heavy defoliation occurred between Nakusp and Edgewood, also at Elko and Morrissey. Light to medium defoliation was noted at intervals between these general areas.

1944—Population levels were generally low with light outbreaks at Trinity Valley and Arrow Lakes Valley.

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1. Contribution No. 466, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.
3. Information was gathered from the records of the Forest Biology Laboratory, Vernon, B.C.

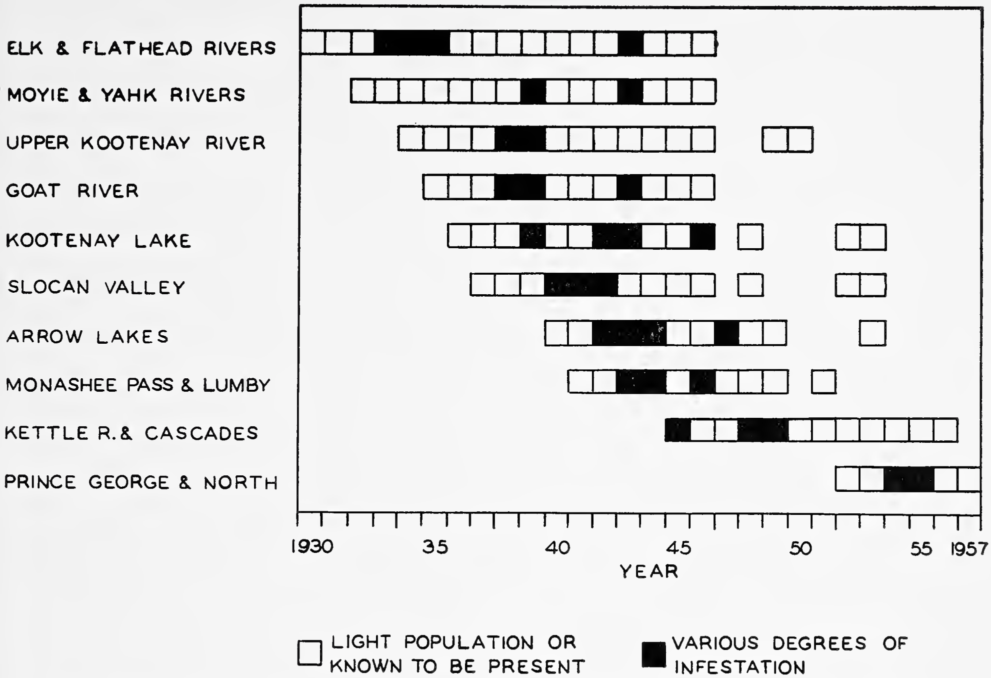


Fig. 1.—Population trends and infestations of *Pristiphora erichsonii* (Htg.), from 1930 to 1957 in British Columbia.

1945—The insect was observed in the Penticton area and Christian Valley. An infestation occurred on the Rossland-Sheep Creek Summit. From Nelson eastward the population was "very light."

1946—Lumby and Hall Creek (near Salmo) were the only localities where damage was recorded.

1947—An infestation appeared at Whatshan Lake.

1948 & '49—A light infestation occurred in the vicinity of Grand Forks, Eholt, and Phoenix. Elsewhere the insect was scarce.

1950 & '51—The larch sawfly was very scarce in Survey collections and all infestations in southeastern British Columbia had subsided.

1952—A few Survey collections from points west of Creston contained larch sawfly larvae. They were also found for the first time on eastern larch in the northern part of the province at Mill Creek west of Fort Nelson.

1953—Larch sawfly was present in small numbers at scattered points, mostly on the Kettle River drainage.

1954—The situation was unchanged in the south but an infestation developed at Cluculz Lake west of Prince George where there are scattered stands of eastern larch.

1955—The insect was very scarce on western larch in all areas. A few larvae were collected at Pantage Lake southwest of Prince George, the southern extremity of the range of eastern larch in British Columbia. A light infestation occurred at Cluculz Lake. Presence of the insect was indicated by curled leaders at Commotion Creek west of Dawson Creek.

1956—A few larvae were found in a concentrated search in the Phoenix area near Grand Forks. One colony was found at Cluculz Lake west of Prince George.

1957—The larch sawfly occurred in one collection made along the Hart Highway west of Dawson Creek, the only known record of the insect for 1957 in British Columbia.

The population trends and infestations of the larch sawfly since its appearance in British Columbia about 1930 are depicted in Figure 1. Figure 2 shows the approximate range of western and eastern larches in the province and areas where infestations of larch sawfly are known to have occurred. The Shuswap Lake area is the only part of the western larch

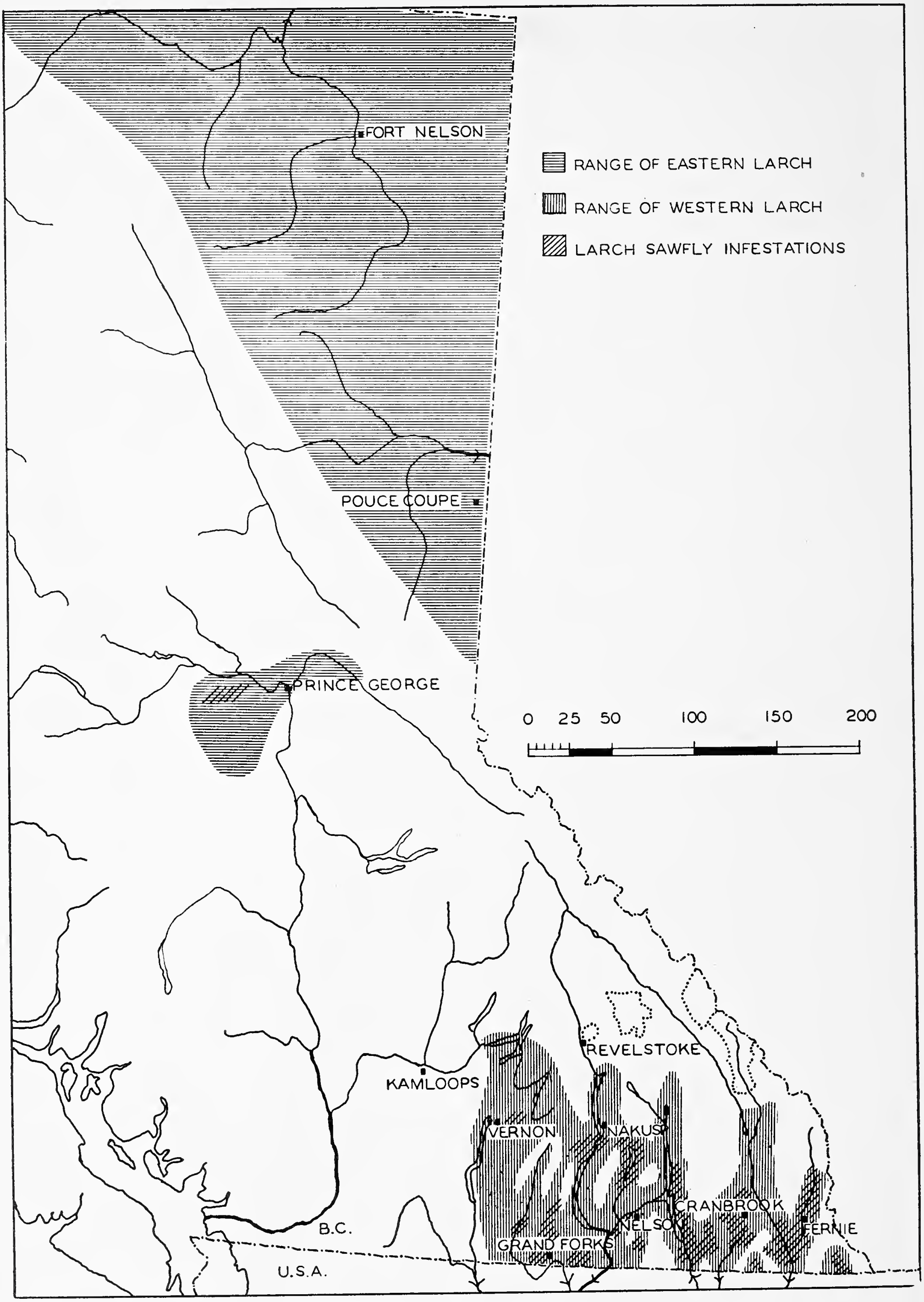


Fig. 2.—The ranges of *Larix occidentalis* Nutt., and *Larix laricina* (DuRoi) K. Koch and known areas where infestations of *Pristiphora erichsonii* (Htg.) have occurred since 1930 in British Columbia.

range where the insect has not been found. Alpine Larch, *Larix lyallii* Parl., occurs at high elevations over much of the range of western larch, but has never been recorded as a host of larch sawfly in British Columbia.

**References**

McLeod, J. H. 1951. Notes on the population and parasitism of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Hymenoptera: Tenthredinidae), in British Columbia. Ent. Soc. B.C. Proc. (1951), 48:81-85.

Hopping, G. R., H. B. Leech, and C. V. G. Morgan. 1943. The larch sawfly, *Pristiphora erichsonii* (Hartig) in British Columbia, with special reference to the cocoon parasites *Mesoleius tenthredinis* Morley and *Tritneptis klugii* (Ratzeburg). Sci. Agric. 24(2): 53-63.

## A Record of a Sand Cricket, Stenopelmatinae, from the Coastal Wet Belt of British Columbia

The Stenopelmatinae constitute the first of five sub-families of the Tettigoniidae or long-horned grasshoppers that occur in British Columbia. Insects of this sub-family, generally called Sand or Jerusalem crickets, have enormous, smooth heads and heavily spined front legs for digging in the sandy soil in which they live. They are nocturnal, hiding by day in burrows excavated under stones and bits of wood.

In his list of the Orthoptera of British Columbia (1), Buckell records three species: *Stenopelmatus fuscus* Haldeman of which he collected one specimen from Fairview, just south of Oliver; *S. longispina* Brunner, recorded from Vancouver by Carl Brunner (in Vehr-Zoll-bot. Gesellsch. Wein XXXVIII, p. 261, (1888)), and *Cyphoderris monstrosus* Uhler, the nocturnal wood cricket which is common in the Dry Belt in the aspen groves that fringe timber line.

Specimens of *Stenopelmatus* have no traces of wings; *Cyphoderris* males have short, stubby tegmina with which they stridulate, but the females are entirely wingless. I have taken a few specimens of *S. fuscus* from under boards near the international boundary at Osoyoos but had no record from the coast until I received a full grown specimen from Mrs. Minnie Peterson of Semiamu Bay who said it was destroying potatoes in her garden. Now this bay is given, in the Geographical Gazetteer for B.C. as "Georgia Strait East of Boundary Bay, New Westminster District" and may well be considered the Vancouver region. Therefore the specimen I received from Mrs. Peterson is probably *Stenopelmatus longispina* Brunner and it would be the first taking of this insect since 1888, the second record for the province.

I immediately wrote to Mrs. Peterson begging her to sacrifice her potato patch for the sake of science and to collect me all the specimens she could, but the first is the only one received so far; Mrs. Peterson is apparently not a scientist, or the insect is excessively rare at the coast.

**Reference:**

(1) Buckell, E. R. 1930. The Dermaptera and Orthoptera of Vancouver Island. Proc. Ent. Soc. B.C. **27**: p. 46.

—*G. J. Spencer, University of British Columbia.*

## *Melandrya striata* Say at Vernon, B.C. (Coleoptera, Melandryidae)

The occurrence of *Melandrya striata* Say at Courtenay, B.C., has been recorded by Gregson (Ent. Soc. B.C., Proc. 41.36, 1944). The only other B.C. specimens that I have been able to locate are in the Canadian National Collection; one is from Victoria and the other is of doubtful authenticity as there is no locality on the label.

On May 16 and 17, 1950, I collected 13 larvae, 4 pupae and 5 callow adults of this beetle from stumps of white birch *Betula papyrifera* Marsh, 8 miles east of Vernon, B.C. The larval galleries were traced to a depth of 4 inches in the rotting wood, but the pupal cells were mostly within an inch of the surface.

—*J. Grant, Forest Biology Laboratory, Vernon, B.C.*

## A new record of *Annaphila arvalis* Hy. Edw. in British Columbia

I took a fine specimen of *Annaphila arvalis* in Saanich, Vancouver Island on March 10, 1958. This appears, from my information, to be the first record since two were taken by E. M. Anderson at Goldstream, V.I., March 22, 1903.

This species formerly masqueraded as *Brephos fletcheri* in our published lists, but recent investigations have shown its real status (see Provincial Museum Report 1952).

Some doubt has existed that it was present in B.C. since no specimens had been taken for so long. Evidently it is an insect that cannot be collected deliberately owing to the fact that its habits do not coincide with our method of approach. It seems to be met with only by pure chance and good luck.

The caterpillar is known to feed on *Montia perfoliata,* therefore it should be looked for where this plant grows, but always very early in the season.

—*George A. Hardy.*

# A NEW ASPECT ON THE FAUNAL CONNECTIONS BETWEEN EUROPE AND THE PACIFIC NORTHWEST

G. G. E. SCUDDER
University of British Columbia

Lindroth (1957) in an excellent book entitled "The Faunal Connections between Europe and North America" has dealt with the animals, especially the insects, common to the two continents. He shows that the introduction of foreign plants and lower animals in Newfoundland has been brought about, to a large extent, by their unintentional introduction in ballast. Hence there is no need to postulate land bridges, etc. This ballast was carried over in sailing vessels of the North Atlantic trade and dumped on or just off-shore from the areas in which these vessels loaded cargo for shipment to Europe. It was found that much of the ballast transported to Newfoundland originated from southwestern England.

On pp. 170-172, instances of similar ballast dumping in the Pacific Northwest are cited: one for Puget Sound and one for Portland, Oregon. Dr. J. R. Adams of the University of British Columbia tells me that Departure Bay, just north of Nanaimo on Vancouver Island, was a centre for ballast dumping: coal mined there from 1852 on was shipped to all parts of the world. Figs. 7 and 8 in Lindroth's work show the distribution of introduced species of *Carabus* in North America, and shows the area around Vancouver to be one of the primary centres. It is suggested that the ballast dumping in this area may have played a considerable part in introducing European forms to the area. Most of the European insects introduced into the Pacific Northwest have been late arrivals compared with eastern Canada; this is correlated with the fact that the Panama Canal was not opened until 1914. We do not know, at present, the place of origin of the ballast dumped in the Pacific Northwest. Perhaps much of it also came from Southwestern England.

Varley (1958) in a review of Lindroth's book, when discussing the groups of animals considered therein, states that "the vast majority of animal groups are excluded because taxomic study is insufficiently advanced, and careful collation of the described species on the two sides of the Atlantic has yet to be undertaken." The present author has collected Heteroptera in Great Britain for the past 11 years and is now undertaking such a collation in this group. Whilst collecting with Dr. W. J. Le Quesne, in southwestern England in 1956, the author took the opportunity to collect in many of the areas, mentioned by Lindroth as those from which ballast was taken.

It is of interest to note that a number of the species of Hemiptera, recorded as new to British Columbia since 1914 by Mr. W. Downes are of European origin. The author hopes to be able to collect specimens and trace records of ballast dumping for the Departure Bay area. Any assistance in this field would be greatly appreciated.

**References**

Lindroth, C. H. 1957. *The Faunal Connections between Europe and North America.* New York.
Varley, G. C. 1958. Review: Lindroth, C. H. *The Faunal Connections between Europe and North America.* Ent. mon. Mag. **94:** iii.

# INSECTS CAUSING SEED LOSSES IN DOUGLAS FIR ON VANCOUVER ISLAND IN 1957[1]

A. F. Hedlin

Forest Biology Laboratory, Victoria, B.C.

Previous work on cone and seed insects on Vancouver Island has indicated that insect-caused seed losses in Douglas fir are important (Graham and Prebble, 1941; Radcliffe, 1952). However, these studies were interrupted before a conclusion was reached.

The present study was started in 1957. The object is to determine first what insects are present and their relative importance in causing seed losses in Douglas fir. There are a number of insect species involved and it is hoped to identify at least those of economic importance. The life histories and seed-destroying capabilities will be studied and eventually experiments in chemical and cultural controls will be carried out. Thus it is hoped that it will be possible to reduce insect-caused seed losses within restricted areas, such as seed orchards.

To study cone production and seed losses on an area-basis one plot was measured out at each of four different elevations in the Cowichan River area of Vancouver Island. In each plot, potential cone-bearing Douglas-fir trees were tagged. These trees will be examined each year for cone and seed production and for records of insect losses at the different elevations. Plot elevations ranged from 400 to 1625 feet.

Biological studies were carried out by examining cones for insects and damage at regular intervals from time of pollination until cone maturity. In this way complete series of immature forms were obtained and their damage noted. In early spring, eggs were obtained and later observations yielded larvae of the different instars through to the pupal stage. Four hundred and ninety cones were dissected scale by scale.

## Results

The insects of importance can be conveniently divided into three groups: seed chalcids, cone moths, and cone gall midges.

### *Megastigmus spermotrophus* Watchl family Chalcididae

The biology of the seed chalcid *Megastigmus spermotrophus* is well known (Hussey, 1955), so little time was spent on it. The egg is laid within the young seed in the spring. After hatching, the larva feeds on the developing seed and by the time it is fully grown has devoured the inside of the seed. It remains in the seed over winter, pupates and emerges the following spring. Each insect destroys one seed.

### *Barbara colfaxiana* (Kearf.) family Olethreutidae and other cone moths

The cone moths have received much more publicity than other Douglas-fir cone insects with the possible exception of *M. spermotrophus.* The reason for this is probably that they are larger and their feeding activities are more conspicuous than the other important species. *Barbara colfaxiana* is the species to which almost all the blame is attached. According to Heinrich (1923) there are three different forms or varieties causing damage to cones of Douglas fir and several others which attack cones of other conifers. In this study, larvae of other lepidopterous forms were obtained also, including *Dioryctria* sp. and several smaller unidentified forms.

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1. Contribution No. 458, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

1. Personal communication: F. P. Keen, California Forest and Range Exp't. Stn., Lafayette, Calif., Jan. 1958.

2. Personal communication: N. E. Johnson, Weyerhaeuser Timber Co., Forestry Research Center, Centralia, Wash., Jan. 1958.

The adult *Barbara colfaxiana* emerges in March or April and lays its eggs, usually singly, on the exposed portions of the cone bracts. When the larva hatches it begins to feed on the bract tissue and migrates into the cone where it feeds mostly on scale tissue for some time. The late-instar larva feeds on scales and seeds without showing any particular preference for either. In late summer it bores a tunnel to the surface of the cone and at the same time discharges frass, which adheres to the surface of the cone in pitch. The insect then forms a tough cocoon near the axis of the cone in which it pupates. It remains there over winter.

Damage resulting from the feeding by this insect can be divided into two categories, direct and indirect. Direct damage to seeds is simply the result of feeding on the seed. This is easy to assess. Indirect damage is the effect which injury to conductive tissues may have on developing seeds. The larva wanders around in the cone and obviously the damage to surrounding tissue will affect neighbouring seeds. The extent of this type of damage is more difficult to assess. Radcliffe (1952) found a significant difference in seed-viability between seeds from infested and uninfested cones. When only one larva is present a cone may develop quite normally, but when several are present the apical half of the cone is often killed before maturity. In 1957, 23 per cent of the cones in plots were infested with *B. colfaxiana* and the average direct damage was 3.6 ovules and 1.9 scales per cone. The average damage to ovules in one severely infested tree was 9.6 per cone.

**TABLE I.—Percentage Douglas-fir cones infested with cone moths and gall midges.**

| Location | Elevation | No. of trees: Total | No. of trees: Produced cones 1957 | Percentage cones infested: Cone moths | Percentage cones infested: Gall midges |
|---|---|---|---|---|---|
| Plot 1 | 1625 | 33 | 7 | 50 | 32 |
| Plot 2 | 1300 | 42 | 11 | 8 | 11 |
| Plot 3 | 925 | 41 | 5 | 0 | 62 |
| Plot 4 | 400 | 60 | 4 | 20 | 90 |

## The Cone Gall Midges, Family Cecidomyiidae

The third group comprising the gall midges of the family Cecidomyiidae has received little attention, but some of its members are very destructive. Graham and Prebble (1941) recognized their potential as seed-destroyers but little mention has been made of them since. Some of the species occurring in Douglas-fir cones have been described by Foote (1956) but there is still uncertainty as to identification of some species. Keen[1] states "there are at least four species of gall midges (Itonididae) found in Douglas-fir cones and possibly more." The one which causes most damage lays its eggs in clusters near the base of the scales of the young cone. When the eggs hatch, the young larvae enter the soft scale tissue and form a polythalamous gall which usually destroys the seed. When few larvae establish themselves, the seed may form but becomes fused with the scale, and is not released from the cone. In the fall the larvae leave the cone to enter the duff, and emerge the following spring. Under natural conditions pupation probably does not occur until spring.

Gall midges infested 33 per cent of the cones in the plots and caused an average of loss 4.4 seeds per cone. The maximum seed-loss recorded in one cone was 32. Infestation of cones ranged from 11 to 90 per cent in different plots. Johnson[2] reported these insects to be serious in the State of Washington also.

## Discussion and Summary

This study is aimed at separating the different species and their damage, working out their life histories, and determining a means of control for the important species in seed orchards. It is difficult to draw definite conclusions following only one year's work. However, it is apparent that a number of insect species are involved and that some of these are potentially capable of destroying appreciable amounts of Douglas-fir seed.

In 1957, seed chalcids, cone moths, and cone gall midges were present in appreciable numbers with the latter being the most important single group.

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## Two remarkable Moth Chrysalises

Towards the end of May 1925, I received from the government fumigation station in Vancouver, four sapling Chinese elms with curious hard lumps projecting from the stems. The lumps were smooth, oval, nearly ½ inch long by 5/16 inch wide, striped with six alternate brown and white longitudinal bars and were stuck tightly to the stems. I had an idea that they were of lepidopterous origin so kept them in the laboratory.

On June 20 when working at a table I heard a curious little "plop!" and immediately something flashed to the window which fortunately was closed, and banged up against a pane. It was a stout-bodied brownish-orange-yellow moth with a wing spread of about 1⅛ inches. Closely watching the other lumps on the stems, I was fortunate enough to see the emergence of another moth; suddenly the rounded top of the chrysalis, like an operculum, flew off with a click and in one fluid movement, without the pause for wing expansion and drying common to most moths, this one emerged from the chrysalis and flew straight towards the light, to hit the window with a thud.

Having no references to Chinese insects, I consulted Maxwell Lefroy's "Indian Insects" and found an illustration and brief description of a very similar moth; it belongs to the Limacodidae, closely related to the Eucleidae or flannel moths which have caterpillars with extremely irritating spines.

In the Blackmore-Wynne collection of Lepidoptera at the University, are specimens of only one species of Limacodidae in this Province, *Tortricidia testacea crypta* Packard, from Saanichton and Enderby, with no notes about its chrysalis.

The emergence of these moths from their hard chrysalises is so remarkably swift as to raise the question "Why?". Every other moth that I have ever heard of or seen takes some little time for the expansion and drying of its wings and the large silk worm moths take several hours. Against what enemies or danger is this moth so protected that it emerges from its chrysalis like a jack-in-the-box?

The second remarkable chrysalis was brought to my attention by Mr. F. Jackson, 440 E. 35th Avenue, Vancouver, who rang me up in June 1957 to ask "What insect is made of gold?" As usual in such cases, I said that I did not know but to send in specimens. In a few days he sent some withered leaves tied into clumps with scanty silk and showing in spots, touches of gold. On tearing open the leaves I was amazed to find small obtected pupae of pure, polished gold, the most beautiful things imaginable. For once a citizen was correct, they *were* of gold. From July 2 to July 5, four moths emerged from these pupae leaving behind them delicate empty cases with only the faintest tinge of gold. The moths are geometrids *Sicya macularia crocearia* Packard and from the Blackmore-Wynne collection I find that they are quite commonly distributed at the coast and at Enderby where Mr. Wynne lived, and in the southern interior. Larvae of the form *macularia* are recorded by Llewellyn Jones as feeding upon *Acer, Betula, Vaccinium, Spirea, Pinus contorta, P. monticola* and *Tsuga,* a very wide range of food plants. It would be interesting to know if all the pupae from larvae that feed on such diverse hosts have this polished gold reflection.

The moths, nicknamed "Pink-bordered Yellow" by Blackmore, possess none of this metallic sheen; and the nickname indicates, the colour is yellow with a pinkish-brown margin on the front wing. I can find no references accounting for metallic gold in insects. Other colours, especially yellows, are accounted for by pigments and environmental factors, but not gold. The gold in these pupae may be pigment, rendered metallic by interference lines, that emerges in the adult wing as yellow.

Finally it is of interest to note that the word "Chrysalis" comes from the Greek "Khrusallis" meaning "golden thing". Did the first entomologist-etymologist to employ that word *Chrysalis* to the obtect pupae of Lepidoptera, have before him the metallic golden pupa of this insect *Sicya macularia?* —*G. J. Spencer, University of British Columbia, Vancouver.*

# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART VIII — *SEMIOTHISA* SPP. (GEOMETRIDAE)[1]

D. A. ROSS[2] and D. EVANS[3]

The larvae of *Semiothisa* spp. are leaf eaters; seven of the forest species feed on conifers, three on deciduous-leaved hosts. None has been known to occur in destructive numbers in British Columbia. The larvae are medium-sized loopers: some species are green with white stripes, a few have two colour phases. All species overwinter as naked pupae in the duff.

**S. adonis** B. & McD. *Pinus ponderosa, P. contorta, P. monticola, Pseudotsuga taxifolia* (3), *Larix occidentalis* (1); southern B.C.; rather uncommon. **Larva:** 1⅛ inches; head, pale green, dull reddish patch above and before ocelli; body, green; cream-coloured subdorsal stripes (includes abdominal setae ii of Dyar and Forbes) continuous onto the head; broader cream subspiracular stripe.

**S. granitata** Gn. *Pseudotsuga taxifolia, Picea engelmanni, P. glauca. P. mariana, P. sitchensis, Tsuga heterophylla, Abies lasiocarpa, A. grandis, A. amabalis, Pinus contorta, P. monticola;* believed to be accidental on *P. ponderosa* and *Larix* spp. Generally distributed; sometimes very numerous over small areas. In 1949 numerous adults emerged during early fall; normally the species overwinters in the pupal stage. **Larva:** 1⅛ inches; head, greenish, with dark reddish-brown blotch or herringbone pattern on sides, occasionally also on vertex; body, green; middorsal area dark; white subdorsal stripe ventrad of setae ii; whitish "bloom" over dorsum; fine blackish lines on dorsum, below subdorsal stripe and on subventer (these blackish lines may be obscured by the "bloom"; cream spiracular- subspiracular stripe; white lines on venter.

**S. perplexa** McD. *Pseudotsuga taxifolia, Picea engelmanni;* southern Interior with a few records along the southern and central Coast. **Larva:** apparently similar to *S. granitata.*

**S. sexmaculata** Pack. *Larix occidentalis, L. laricina;* southern Interior on western larch and central Interior north into the Yukon on eastern larch; frequently numerous. Sometimes this species has a partial second brood. **Larva:** length ¾ inch: **green phase** — head and body green; white addorsal lines dorsad of seta i; broader white subdorsal stripe ventrad of ii, bordered below by black line; cream subspiracular stripe; white midventral and subventral lines; no black lines on venter; **brown phase** — head, off-white, with brown blotch or herringbone pattern on vertex; body, off-white, overlaid with brown; irregular broad anteriorly directed dark brown wish-bone mark on the dorsum of each abdominal segment.

**S. triviata** B. & McD. *Juniperus scopulorum;* Australian, Marguerite, Alexandria, Williams Lake, Mara Meadows, Fort Steele, Hedley. **Larva:** ¾ inch; head, off-white with irregular brown patch through setae ii (Dyar); pale herringbone pattern on vertex;

1. Contribution No. 459, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.
3. Forest Biology Laboratory, Victoria, B.C.

frons black; body brownish; small off-white subdorsal patches at anterior margin of each body segment; black irregular V patch containing each abdominal spiracle continuous forming V's on venter of abdominal segments; off-white patch anterior to each spiracle.

**S. teucaria** Stkr. *Quercus garryana;* southern Vancouver Island. **Larva:** ¾ inch; dull lime-green, wide pale subdorsal stripes; yellow spiracular line; ventral and anal prolegs marked with crimson.

**S. setonana** McD. *Juniperus scopulorum;* southern Interior. **Larva:** 1 inch; greenish head, may have light brown herringbone pattern; white patch on either side of frons containing seta ii (Dyar); body, green (apparently there is also a grey phase); subdorsal stripe broken, irregular; small blackish spot at intersegmental area on dorsum; black V patch through spiracles; white patch anterior to spiracle and rusty patch below; four white lines on venter.

**S. neptaria** Gn. *Salix* spp.; southern and central Interior, Vancouver Island. **Larva:** 1 inch; head, reddish brown with curved brown band above frons; body, yellow-brown; broken white addorsal lines; brownish patch under abdominal segment 2.

**S. hebetata** Hlst. *Salix* spp.; Canal Flats, Connell Creek, Manson Creek, LeJeune Lake and at various points in the Yukon between miles 916 and 1190 on the Alaska Highway. **Larva:** 1 inch; head, brownish with black transverse lines above and below frons; body, dark purplish-pink with banded appearance; broken, off-white or yellowish addorsal line and subspiracular stripe; blackish patches about spiracle.

**S. continuata** Wlk. *Tsuga heterophylla, Thuja plicata;* southern Coast. **Larva:** ½ inch; head, large and green; body, bright green with cedar-twig-like pattern; broken white lines; pale spiracular line.

## BOOK REVIEW

Annual Review of Entomology, Vol. 3. (*E. A. Steinhaus* and *R. F. Smith,* editors). 1958. Annual Reviews, Inc. Palo Alto, Calif., pp. vii - 520.

A slightly astringent reviewer of entomological books for the Quarterly Review of Biology, Prof. George C. Wheeler, complained (*Ibid* 32 (2): 191)) that Vol. 1 of this series "might have been more appropriately entitled an 'Annual Review of Applied Entomology' since 70 per cent of its pages are devoted to that branch". His criticism is no longer valid; Vol. 2 had about 45 per cent economic content, and Vol. 3 has a mere 30 per cent. In this reviewer's opinion, the balance is now about right. Much of the support for the parent society and the Annual Review comes from applied entomologists, entitling them to their one-third share, even to the section on air-blast spraying which seemed particularly to irritate the critic mentioned. Since some of the best current work is applied, or at least economically motivated, the editors can scarcely reduce the economic papers below their present level and still claim to represent the profession.

The volume seems to be top-heavy with U.S. contributions in the proportion of 15 to 8 for the rest of the world. Origins of the latter are: the U.K. 3, Canada 3, Australia 1, and France 1. The non-English speaking world seems to be poorly represented. Of the 64 papers in the first 3 volumes, only 2 have come from Continental Europe, none from Scandinavia, India or Russia. Would not an occasional review by region as well as by topic be acceptable? A chapter entitled, for example, Entomology in the U.S.S.R. would be read with considerable interest.

Two minor irritants persist in Vol. 3, both concerning the citation of literature. In soliciting a review, could not the editors suggest that the names of authors cited be left out of the text, except when discussing differences of opinions as in A. J. Nicholson's "Dynamics of Insect populations"? The text is more swiftly read without them, and the reputation of the reviewer himself should be the guarantee that only the best contributions in the field are being surveyed. The second criticism follows from the first.

In a review, the sources are of prime interest, hence it is no more than courteous to list them alphabetically so that they are quickly available. Fortunately, only 9 of the 23 reviews have non-alphabetic references, not including the largest list with 285 titles.

The authors and topics for Vol. 4 have been announced. It appears that the high standards are to be maintained.

*H. R. MacCarthy.*

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# PROCEEDINGS

of the

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**Volume 56. Issued November 4th, 1959**




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# PROBLEMS IN THE COMPILATION OF A SPRAY CALENDAR FOR ORCHARDS IN BRITISH COLUMBIA[1]

D. P. Pielou[2]

## Introduction

Criticisms of the increasing complexity of pest control recommendations for certain types of crops, particularly fruit, are not infrequent. Such recommendations are usually made in the form of a so-called "spray calendar." The writer was successively secretary, vice-chairman and chairman of the committee responsible for the annual drafting of the spray calendar in British Columbia and, of necessity, took a central part in the many discussions as to the function, content, and format of the calendar. During this period the general structure of the calendar was considerably altered and this paper is an effort by the writer to give his views on the present situation.

It is illuminating to look at the British Columbia tree-fruit spray calendars for 1957, 1958 and 1959 (2, 3, 4) and compare them with the calendar for 1936 (6). It is best to go back no farther than twenty years or so, so that we remain in modern times with roughly the same serious insect pests and diseases as we have today, and roughly the same outlook and the same problems of orcharding in general.

In 1936 the tree-fruit spray calendar for British Columbia mentioned 18 pests and six diseases. It listed seven materials (lime-sulphur, oil, bordeaux mixture, nicotine, lead arsenate, strychnine and whitewash). Of the seven, three are deadly poisons. The calendar referred to the same six tree-fruits as it does today—apple, pear, peach, apricot, prune and cherry. In 1957 the same spray calendar (now called "Control of Tree-Fruit Pests and Diseases; With Information on Spray Thinning and Stop-Drop Sprays") covered 39 pests and 14 diseases (not counting virus diseases) and listed 33 pesticides. Although several of these pesticides are mild poisons, only two rank as deadly poisons (nicotine and strychnine; the latter for mice).

In 1936 the calendar was composed of approximately 2200 words, together with some 330 more on small fruits. In 1957 the number of words had increased to over 4000 and the information on small fruits had grown into a separate calendar.

The number of pests and diseases needing attention has approximately doubled in 21 years; but the number of materials has increased fourfold. Words have only doubled but the more leisurely phrasing of 1936 has given place to a brief, perhaps too brief, telegraphic style in 1957 in order to impart the information as concisely as possible. It is worthwhile noting, however, that in the 1957 calendar there are sections on spray-thinning, stop-drop sprays, mineral deficiencies, surfactants, and operation of concentrate sprayers, that were not included 21 years ago.

However, before we get too critical of our own affairs, let us look outside British Columbia. In Washington State the spray calendar (12) is now issued in the form of a 40-page booklet, using nearly four times as much paper as our own. It refers roughly to the same pests but mentions 48 chemicals against our 33. And Ontario issues three calendars to cover only five tree-fruits (9, 10, 11). Nova Scotia (8) and Quebec (7) each issue a single calendar for apples and pears; soft fruits are not grown on an appreciable commercial scale in these provinces (21).

## The Background of Orchard Entomology in British Columbia

Recommendations for insect and pest control are influenced by various factors.

[1] Contribution No. 1, from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.
[2] Entomologist.

1. In the dry Okanagan Valley, where most of the tree-fruits of British Columbia are grown, insects, rather than diseases, dominate spraying practices.

2. Six fruits are involved and these are often planted in one small orchard, in several varieties. Interplanting is common in British Columbia and, in the interests of time and simplicity, orchardists favour pesticides that can be put usefully on all fruits.

3. Different fruits have different insect faunas. In British Columbia 46 species are listed (17) as of major economic importance on one or more of the six tree-fruits of the province. Of these, 28 occur on apple, 12 on pears, 10 on apricot, 11 on peach, 15 on prune and 12 on cherry. Some species, at a level sufficient to cause damage, occur on several fruits. But many of the most serious pests, and these dominate the spray programmes, occur on one or two tree fruits only, e.g., codling moth *Carpocapsa pomonella* (L.) on apple and pear; peach twig borer *Anarsia lineatella* Zell. on peach; black cherry aphid *Myzus cerasi* (F.) on cherry; pear psylla *Psylla pyricola* Foerst. on pear and mealy plum aphid *Hyalopterus arundinis* (F.) on apricot and prunes.

4. Susceptibility of various fruits, and varieties, to damage by different chemicals varies, often very greatly. For example, Trithion [*O, O*-diethyl *S*-(p-chlorophenylthiomethyl) phosphorodithoate] causes damage to the Golden Delicious and Red Delicious varieties of apple (36); so much so, that in spite of its otherwise excellent qualities as an orchard insectciide, we gave up intentions of recommending it in British Columbia. Fortunately there are suitable alternatives (37) with somewhat similar properties but lower phytotoxicity. A newly introduced pesticide, which proves phytotoxic in our orchard trials to any of our more important fruit varieties, is usually discarded if there are suitable alternative materials available.

5. A major factor in the selling of fruit today is that the fruits should have a very high finish. This is quite distinct from such obvious defects as worminess or gross misshape. The factor is purely an aesthetic one, something that would not arise in a hungry nation; it can be regarded as ridiculous but, nevertheless, it is most important in the sale of fruit. And the economic entomologist, being necessarily concerned with the economics of the industry that supports him, cannot afford to neglect it. The fact, from his professional point of view, is that the surface of fruits makes an excellent display surface for any sort of insect or disease damage, however trivial, and for any sort of blemish caused by spray material. Consequently, he must often concern himself with what are, strictly speaking, minor pests and he must be highly selective in recommending spray chemicals. Consider, for instance, the importance of finish in the sale of apples or peaches today as compared with potatoes, or turnips. Though the requirements for finish are much more exacting, ten acres of apples, or peaches, in British Columbia will, in some years, bring the farmer no more net income than ten acres of potatoes or turnips (21).

6. Recommendations made by the orchard entomologist must fit in with other orchard practices. The orchard entomologist is necessarily closely allied to the horticulturist and to the practices of actual fruit production. His position is quite unlike that of a medical entomologist working on, for example, malaria-carrying mosquitoes; such an entomologist is seriously concerned with only the one or two species of anophelines that are vectors which occur in his area; and there may be little reason for him to be in close contact with the medical man working on drugs for the cure of the disease. For instance: efficient concentrate spraying is only possible if adequate pruning has been done (40); fungicides used by plant pathologists can increase or decrease mite populations (33); the water and nitrogen balance of fruit trees almost certainly (36) affects aphid populations as it does in other plants (19); though lindane [1,2,3,4,5,6,-hexachloro*cyclo*hexane] does not have the

tainting properties of the less pure benzene hexochloride (38) on fresh fruit, nevertheless, its taste can be detected in the processed apple sauce that is produced on a large scale in British Columbia as a means (21) of removing low grade apples from the fresh fruit market; compatibilities of insecticides have to be considered, not only with fungicides, but with blossom-thinning, "stop-drop" and minor-element sprays (35); at certain times spraying cannot be done with a concentrate machine because of the presence of tree-props in the orchard; and late-season application of pesticides is not always possible, not only because of the dangers of exceeding legal residue tolerances (20), but because unsightly, if innocuous, deposits of spray material may depress the grade of the fruit at the packing house (37).

## How Comprehensive Should a Spray-Calendar Be?

The slowly increasing pest fauna, the rapidly increasing number of new chemicals, and the development of pesticide tolerance in insects and mites (18), inevitably brings up this question. Should a spray calendar include all available information on pest and disease control procedures? Or should it be restricted to a few of the most important pests and diseases, and most important control measures? A skeleton outline of essential control measures could almost be put on a postcard and some growers would like nothing better. But extension horticulturists want all the current information available; and many growers want some scope for choice in their spray programmes based on their experience of conditions in their own orchards.

The policy up to the present has been to make the British Columbia calendar fairly comprehensive; District Horticulturists have then abstracted, and issued in typewritten form, a brief minimum spray schedule for their own local areas. This, in fact, emphasizes why it would be unwise to restrict the general calendar in content; for what one District Horticulturist would consider the minimum schedule for his own area is not necessarily suitable for another area. For within a distance of 100 miles or so in the Okanagan Valley, there are quite large differences in insect fauna; in rainfall, soil and frost conditions; and in the fruits and varieties predominant (21, 24). For instance, south of Okanagan Falls the presence of San Jose scale, *Aspidiotus perniciosus* Comst., determines, to a large degree, the nature of dormant spray treatment; lime-sulphur plus oil is an essential recommendation there (23). In the Vernon area, on the other hand, San Jose scale is not present, and the addition of oil to the dormant spray may be a needless expense. The appearance of resistance to pesticides in insects and mites has been, in the first place, sporadic and restricted in location. This has been the situation in British Columbia with resistance to organic phosphates in the European red mite, *Panonychus ulmi,* (Koch), the apple rust mite, *Vasates schlechtendali* (Nal.) and possibly other mites (16, 31). The appearance of DDT-resistance in the codling moth, in 1957, was also localized, not merely as to geographical locality, but also in individual orchards in a given area (27). In the most recent British Columbia spray calendar (4), specific mention was given to recommendations for resistant strains.

There have been other reasons for increase in size of the calendar in recent years. The calendar originally referred to the application of chemicals as sprays for pests and disease control, together with information on the few pesticides not applied by this method. In the past six or seven years, however, the entomologists' and pathologists' techniques of spraying have been extended to the thinning of fruit by the application of materials that act by destroying most of the blossom (13). The chemicals used in British Columbia are dinitro-*o*-cresol compounds similar to those that are applied earlier in the season for insect and mite control, but they are used at a lower dosage. There is, therefore, logical reason for the inclusion of such information on the spray calendar. Mineral salts (zinc, manganese, boron, magnesium) have been conveniently applied as spray solutions (41) and, as these compounds are used to correct physiological diseases, it is legitimate to include them on the spray calendar. Since some of these salts can also be applied by scattering on the ground, this information is also included on the spray calendar for the sake of completeness. However, we may pause to consider where such extensions of the content of the calendar may lead us. Application of such nitrogenous fertilizers as urea may be accomplished by spraying (12), though it is not recommended in British Columbia at present. If it is ever recommended it is reasonable to suggest that such information be put on the spray calendar. However, for completeness again, it might be argued that recommendations concerning conventional soil applications of similar fertilizers should also be included. In a process such as this, the original spray calendar for pests and diseases could grow into a complete outline of recommendations for general orchard practice.

It is fairly obvious that we have enough categories of diverse information on the calendar now, and, if there is any call for further additions, we should consider dealing with all spray applications, other than those for pests and diseases, in a separate publication.

## How Many Calendars Are Necessary?

Ontario (9, 10, 11) issues three calendars and these cover five tree-fruits against our six. However, conditions are somewhat different in Ontario. Acreages are larger and some growers grow only one fruit, e.g., peaches. There is, therefore, good argument for the issue of calendars dealing with only one fruit or group of fruits. As already mentioned, Nova Scotia and Quebec, where soft fruits are not grown on an appreciable scale, each issue a single calendar covering apples and pears only.

However, in British Columbia, although many growers grow apples only, very few grow soft fruits only and very few indeed grow one kind of soft fruit only. Moreover, the peach, the most important soft fruit in British Columbia, has far fewer insect and disease enemies than in Ontario. For instance, two serious peach pests, the Oriental fruit moth, *Grapholitha molesta* (Busck) and the plum curculio, *Conotrachelus nenuphar* (Hbst.) are fortunately absent in British Columbia (17), and these two pests alone force Ontario fruit growers to undertake a spraying schedule (11) at least as extensive as that for apples (3) in British Columbia. Provided, therefore, we can reduce extraneous matter on the calendar, it is reasonable to continue with a single official general calendar. From this one calendar, local horticultural advisors will, no doubt, continue to abstract brief typewritten schedules to suit their districts and preferences. But if, as mentioned in the last section, more categories of information are to be covered in the future, then we will have to consider a second medium of publication; but it is suggested that the division should not be on the basis of separate calendars for separate fruits, for this would lead to much unnecessary duplication of information, as far as recommendations in British Columbia are concerned.

## General Arrangement And Presentation

Twenty years ago the arrangement and presentation of a spray calendar was no great problem. Procedures could be grasped without much difficulty, whatever arrangement was used, because the number of pesticides available was small and did not change much from year to year. Now with much more information to impart, and with annual changes, the design of the spray calendar is a matter of concern if the grower is not to be disheartened by the mass of instructions offered him.

Arrangement may be made in three basic ways:

### 1. Listing by Pests and Diseases

This is, more or less, a catalogue of pests and diseases with alternative control measures, pesticide, rate of application and timing, listed for each. Up to 1957 the British Columbia tree-fruit calendar was of this kind (2). It was definitely not in the form of a programme or schedule for seasonal spraying. But local schedules were compiled from it by district advisory horticulturists. It is extremely economical of space, and involves a minimum duplication of information since a pest or disease is referred to only once, on whatever crop it occurs. Control measures are also listed only once in a separate section and referred to by index numbers opposite each pest or disease.

This form of presentation is the obvious one for entomologists or pathologists whose interests are centred around the insects or diseases. Moreover, the almost complete change, in British Columbia to concentrate spraying has made it possible for the orchardist to apply sprays only when it is obviously necessary, so that a pre-arranged programme, except in the case of codling moth, is no longer necessary. In the past, when the spraying of an average ten-acre orchard might take several days, instead of five or six hours as now, such short-notice spraying was often out of the question.

### 2. Listing by Crops

This is the basic arrangement for the pest and disease-control calendar for vegetable and field crops in British Columbia (5). Here it appears to be a natural method as the number of crops, or categories of crops, is nineteen, and it is difficult to see what other arrangement could have been used. There is also, in this calendar, a section on pests or diseases of a general nature (grasshoppers, etc.).

### 3. Listing by Date

This is a true calendar with the dates of application being indicated: dormant, pre-pink, post-blossom, etc. It is followed conveniently in some calendars devoted solely to one crop, e.g., apple in Ontario (9). If several crops are involved it is followed with difficulty unless some subdivision, on a crop basis, is also made. This is the form that horticultural advisors seem to prefer as most natural for the grower. However, since it soon becomes obvious that the seasonal calendar must be subdivided on a crop basis, some duplication will occur because of insects and diseases that are common to several crops. This means a larger calendar. In fact, the 1958 calendar for British Columbia tree-fruits was revised (3) on this basis and its area is one and one-half times that of the 1957 calendar. Even so, it was found necessary to include a section on "miscellaneous pests" for those pests that did not fit easily into a seasonal spray schedule (earwigs, cutworms, mice, etc.). Such duplication, limited to the extent that all information can be presented on one chart, is perhaps, not entirely undesirable because it can serve to reiterate important parts of the recommendations to growers.

## Introduction of New, and Removal of Old Spray Chemicals

This question has become a major one because of the flood of new materials available. It is a problem that hardly existed before the era of DDT. The following questions arise:

1. How extensive should experimental work be before a new material is recommended to the grower? The entomologist or pathologist normally wants several years of experiment before he is certain of his judgment; for seasonal differences from year to year often profoundly affect insecticidal efficiency, or degree of phytotoxicity. An older generation of orchard entomologists (14), held that a period of not less than five years was necessary to test a pesticide in the field; entomologists of today's tempo have generally shortened this period, but the shortening cannot go too far. An example of this is our recent experience with Trithion (36). This material was so satisfactory, after trials in 1955 and

1956, that we considered recommending it for the 1957 calendar but finally decided against doing so. This was fortunate for the material caused such extensive damage to leaves, and reduced the crop in the 1958 trials, that we have been forced to discard it.

2. If chemicals already recommended are satisfactory, is there any point in emphasizing new materials until they are needed, or unless they have some outstanding new advantage? It is generally felt that the answer to this question is no; however, in practice, very few chemicals already recommended are satisfactory in every respect and usually a case can be made for the inclusion of a well-tested new material.

3. Should cost be a factor in putting a new material on the calendar? New materials are generally relatively expensive; however, the price is usually reduced shortly after the preparation comes into widespread use. The usual practice has been to introduce new materials slowly. Thus, although the effectiveness of diazinon as an orchard insecticide was already apparent to us (37), it was first inserted, in view of its initial high price, on the 1957 spray calendar (2) only for the control of black cherry aphid. This was because there were then objections to almost all other materials used against this pest (37) and the high priced diazinon seemed to have a place in protecting a high-value fruit. A year later (3), with the price substantially reduced, it was recommended for all aphids on tree-fruits and for eye-spotted bud moth, *Spilonota ocellana* (D. & S.). In the most recent calendar (4), diazinon has been recommended against a wide range of pests.

4. Should we introduce a new material, excellent in every respect, but effective against only a few pest insects? Such a policy may lead to an expensive spray schedule in that several materials may be needed in a given application. And, in addition, this policy may lead to the listing of even more materials on the calendar.

5. Should materials be introduced that appear to be incompatible with natural and established biological control? The biological balance between predator (or parasite), and prey, holds insect populations at a fluctuating, but more or less, constant level; however, the level is much influenced by climatic conditions, or by conditions that are themselves influenced by climate (1). It is unfortunate for fruit growers in British Columbia that, under the warm, arid conditions of the interior, the level at which, for instance, codling moth populations persist, is high. Two summer generations and a partial, at least, third generation are usual. With this high biotic potential, control with introduced species of parasites has not been commercially successful in spite of the establishment of the parasites (22). Growers in Nova Scotia are fortunate in that they can rely to a greater extent on natural control and to a lesser extent on chemical control (34); the reverse is the situation in British Columbia (23, 28, 32). Moreover, control with chemicals of moderate toxicity (30) has not been as successful in British Columbia as it has been in Nova Scotia where conditions are such that the codling moth rarely passes through a second generation. The Nova Scotia spray calendar is, in fact, the smallest in Canada for tree-fruits and refers to the fewest chemicals (8). In British Columbia a fully effective material must be used for codling moth whatever the side effects may be. DDT, with its consequent upsurges of mite populations, had to be accepted to save the grower from disaster (22) and Sevin [N - methyl - 1 - napthyl carbamate], which has the same disadvantage, will also have to be accepted now that DDT resistance has appeared in the codling moth in British Columbia (27). On other fruits, however, where DDT has not been so indispensable, we have tried to restrict use of this insecticide; and for the same reason Sevin is, at present, recommended only for apple pests (4).

6. Should highly toxic pesticides be recommended? The use of very poisonous materials such as TEPP [Bisdiethylphosphoric anhydride] is com-

mon on many parts of the world. However, local conditions must determine if official recommendations for such pesticides are to be made. The Okanagan Valley of British Columbia is noteworthy in that practically all the fruit is grown in small, highly-productive, family-operated orchards; although approximately one-half of the total of Canada's annual crop of tree-fruits comes from the Okanagan Valley, this aspect of its production is not generally known. The average orchard is under eight acres and approximately one-fifth of the holdings are less than two and one-half acres (21). There are houses on almost all these orchards. In addition, with the increasing residential population of the Okanagan Valley, many small lots, of a quarter of an acre or so, have been cut out of orchards and sold as homesites. The human population in the rural area is therefore much higher than in many other places where orchards are much larger. The population contains a high percentage of children who inevitably wander into the orchards. The dangers to them, particularly from cover crops contaminated with the more poisonous organic phosphates, can readily be appreciated. Although our attitude in the matter may seem to be unusually rigid, we have therefore adopted, in view of the peculiar British Columbia conditions, a firm policy of not recommending (and therefore doing only limited experimentation on) pesticides highly toxic to man. Our view has been that an adequate selection of reasonably safe materials has been available for the problems of the moment. For this reason we have done little with systemic insecticides until very recently, when suitable systemics of sufficiently low mammalian toxicity, such as Dimethoate [*O, O*-Dimethyl *S*-(*N*-methylcarbamoylmethyl phosphorodithioate] were developed.

7. How should pesticides be recommended to comply with legal tolerance requirements? A new material is not introduced on the spray calendar in British Columbia until a tolerance has been established under the Food and Drugs Act in Canada, and a permanent tolerance established under the Pesticides Chemicals Amendment to the Federal Food, Drug and Cosmetics Act in the U.S.A. The latter requirement is accepted because a considerable portion of fruit from British Columbia is shipped and sold in the U.S.A. and it would not be economical, in packing houses, to keep fruit sorted on the basis of the pesticides it had received during the season. Information that the grower wants, in this respect, is how close to harvest can pesticides be applied without danger of exceeding legal tolerances. Data on this point were included on the most recent calendar issued (4). In estimating these periods, however, other factors besides the purely chemical aspect of residues were considered. According to Mr. K. Williams, Chemistry Laboratory, Summerland, B.C., some materials, such as Sevin, have such a high tolerance that they can be applied the day before harvest, at the recommended rates of application, without fear of exceeding the legal tolerance. However, the wettable-powder formulation leaves an unsightly, though harmless, deposit and removal of such an appreciable deposit would probably add considerably to packing-house costs. Though emulsions do not have this drawback, wettable-powder formulations are preferred in British Columbia (35).

The removal of older materials from the calendar also presents problems. Some chemicals were removed without difficulties. Thus, methoxychlor [1,1,1 - trichloro - 2,2 - bis(*p*-methoxyphenyl ethane], as an alternative to DDT for codling moth, was never very popular with growers and it was removed simply because, since it was more expensive than DDT, very little was being sold. Others, such as cryolite (sodium alumino-fluoride), also once used against codling moth, was rapidly abandoned when something better was available. Since they were no longer used, their removal was no problem. On the other hand, we abruptly removed lindane without reference to the growers, once it became evident that it was being misused and causing tainting of processed fruit. Some materials have been removed very slowly. Thus, the use of dormant oil has gradually declined; mixtures of dinitro compounds and oil are no longer recommended. However, lime-sulphur plus dormant oil still persists because it has been the only consistently effective material against San Jose scale in the southern Okanagan Valley. Nevertheless, the newer organic phosphates and carbamates offer promise against this pest, and it is possible that dormant oil will disappear completely from the calendar before long; unless pesticide-resistance problems increase to the point that we are forced to rely more on dormant oil sprays. Oil is an effective dormant material but is prone to cause plant damage if not used properly; there do not, however, appear to be examples of any insects (18) that have developed resistance to oils.

A few growers use materials (mainly on strength of advertisements in U.S. fruit grower magazines) that have never been recommended in British Columbia. If such materials are registered for use on any plant anywhere in Canada, then there is no legal barrier to their purchase by a fruit grower. Since we have always had good reason for not recommending such materials, nothing is gained by indicating rates of application, etc. for them on the calendar.

## How Many Materials for One Pest?

The reason that several materials are listed for control of one pest or disease may simply be that new materials are recommended, while at the same time, older materials are still widely used and only slowly being supplanted. However, there are often other good reasons why several alternatives should be listed. For instance, up to 1957, six materials (2) were listed for the control of the rust mite, *Vasates schlechtendali* (Nal.). That, on occasion, has been a cause of complaint. The argument has been: why not list just the best one or two measures? In the dormant season the recommended materials included dinitrocresol, lime-sulphur alone, and lime-sulphur plus oil. These alternatives were given because of other pests that might be present at the same time. Dinitro-*o*-cresol controls rust mite effectively and is a more pleasant material to handle than lime-sulphur. On the other hand, if the blister mite, *Eriophyes pyri* (Pgst.) is also prevalent, lime-sulphur is the preferred material because it is more effective than the dinitros against this species. And lime-sulphur plus oil is the best spray material if San Jose scale is present; lime-sulphur alone is less effective and the dinitros are of no use against this species (23). Three different types of summer sprays were also listed for the rust mite because evidence of abundance of the mite may not be apparent until the season is well advanced. The recommended materials were Aramite [2-(*p-tert.*-Butylphenoxy) - isopropyl 2' - chloroethyl sulphite] which is very effective but causes damage on pears (3, 15); Sulphenone [4-chlorodiphenyl sulphone] which is less effective (15) but can be used on pears; and wettable sulphur which is cheap and effective but is more likely to cause foliar and fruit injury than the other two substances (29).

## Problems of Concentrate Spraying

The orchard spray calendar of British Columbia is unique in that it is designed around application of sprays by mobile, air-blast concentrate sprayers. High-volume sprays, whether applied by gun-machines or by automatic equipment, are now little used by orchardists in this province (26). Specification of rate of application was simple with such dilute sprays. Spray mixtures were made up at a given concentration and the material applied until the leaves were dripping; because of this run-off, excess deposition was impossible unless the leaves were allowed to dry and then resprayed. Application by air-blast concentrate sprayers, however, is equally simple provided the machine is correctly designed and adjusted and the rules for concentrate spraying are followed. Marshall (26) has defined efficient concentrate spraying as that in which output, rate of travel, and nozzle adjustment, of the moving air-blast machine is such that the whole tree is uniformly sprayed with no drip from any of the leaves or fruits. There is, therefore, a brief note on concentrate application on the spray calendar. There is also considerable mention, with somewhat different detail, on the compatibility chart (35). Perhaps all the information should be in one place.

Rate of application is specified on the total amount of material to be applied per acre. According to Mr. K. Williams, Chemistry Laboratory, Summerland, B.C., extensive data accumulated over several years show that this amounts, in a mature British Columbia orchard, to specifying the amount of DDT deposited on a square inch of leaf or fruit surface, and in practice if the correct procedure is adopted, the deposits do not vary more than would be expected from a suitable mean value. The instruction on the calendar is: "Determine tank output on acreage basis; e.g., if tankful covers 1¾ acres, use 1¾ times the material listed in column of the chart titled 'amount per acre' when filling the tank." The merits of specifying rates of application in this way have been dealt with by Marshall (26). Attempts to specify the strength of materials in the tank of the concentrate sprayer, without reference to the output-per-acre of the machine, lead to most complex instructions (12).

On the other hand, we do retain a column in the "Formulae" section of the spray calendar that indicates dilutions for application by hand-gun methods. This is because a few growers still own the older machines, and also because the use of dilute spray mixtures applied by hand-guns to the pump of the concentrate machine, is the most economical method for very young trees. Young bearing trees are best sprayed with the usual air-blast concentrate at the standard per acre rate, but with the spray shut off between gaps in the trees. This leads to a lower per-acre output than is indicated on the spray calendar but this is such an obvious procedure that it is not mentioned.

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## A Note on the Gordon Stace-Smith Beetle Collection

In volume 55 (1958) of our Proceedings, I stated that Mr. Stace-Smith had 2400 species of British Columbia beetles in his collection. He **DID** have, but that was a count he sent me some time ago. As soon as he received his copy of our Proceedings he hastened to tell me that he had well over 2700 species, with at least 50 more on hand which would bring the total number to 2800 species, plus or minus a few, all from this Province.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# CONTROL OF THE ROCKY MOUNTAIN WOOD TICK, DERMACENTOR ANDERSONI STILES (Acarina: Ixodidae), WITH GROUND SPRAYS OF DIELDRIN AND HEPTACHLOR[1]

L. Colin Curtis

The Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, is a pest of considerable medical and veterinary importance in Western Canada. Not only may its bite produce tick paralysis, but it is the vector of the causal organisms of at least Rocky Mountain spotted fever, Colorado tick fever, and tularaemia in this region (Gregson, 1956; Banfield, 1956).

Satisfactory control of this pest insofar as it affects livestock is obtainable by spraying the animals themselves with B.H.C. rather than the terrain over which they range (Gregson, 1951b). There remains the problem of protecting human beings who enter the habitat of the tick for recreational purposes, for example in limited areas around campsites and summer cottages. This is a report on the reduction in numbers of the tick by spraying the soil and vegetation with suitable acaricides.

A number of trials of this type have been made in Texas for control of the Lone Star tick, *Amblyomma americanum* (L.), by Smith and Gouck (1945), with DDT; by Gouck and Smith (1947), with DDT, nicotine sulphate, and pyrethrum; by McDuffie *et al.* (1950), with DDT, BHC, chlordane, parathion, and toxaphene; and by Therrien *et al* (1953, 1954), with dieldrin, aldrin, lindane, DDT, chlordane, Sulphenone, Neotran, n-butylacetanilide, and heptachlor, of which dieldrin proved most effective in both mortality and persistence. Gouck and Fluno (1950) carried out plot tests and large-scale aerial sprays in Massachusetts against the American dog tick, *Dermacentor variabilis* (Say), in which both DDT and dieldrin proved effective.

In 1956 and 1957 plot trials were carried out at Kamloops against the Rocky Mountain wood tick, with dieldrin in 1956 and dieldrin and heptachlor in 1957. The site selected was a fairly level, tick-free area of rangeland in the enclosure of the Royal Canadian Naval Ammunition Depot, which was free from interference by man or livestock. The vegetation was typical of overgrazed rangeland, being a mixture of range grasses with Russian thistle, *Salsola kali* var. *tenuifolia* Meyer, and rabbit brush, *Bigelovia graveolens* Nutt.

## Methods and Materials

In 1956, 12 plots of 0.025 acre each were used, arranged in a randomized block. At the start eight of the plots were stocked with ten pairs of wild-caught ticks each, and 24 hours were allowed for the ticks to assume a normal questing position on the vegetation. Four of these plots were sprayed with dieldrin at 0.25 lb. per acre, and the remainder retained as checks. Counts were made after 24 and 48 hours, and weekly thereafter. Since the ticks on the sprayed plots showed a high rate of survival after the second count, a further four plots were stocked a week later. Three of these were sprayed with dieldrin at 0.5 lb. per acre, 20 per cent emulsifiable concentrate being applied in both cases in water with a knapsack sprayer at 40 gal. per acre.

Counts were made by sweeping with a standard tick drag, consisting of a square yard of white flannelette, until the area had been traversed three times without further recoveries. Captured ticks were returned to the plots after being counted.

[1] Contribution No. 2, Entomology Laboratory, Research Branch, Canada Department of Agriculture, Kamloops, British Columbia.

[1] Dieldrin-20, emulsifiable concentrate containing 2 lbs. per gal. technical dieldrin (hexachloroepoxyoctahydro-endo, exo-dimethanonaphthalene), Shell Oil Co. of Canada, Chemical Divn., Toronto, Ont.

[2] Heptachlor 2E, emulsifiable concentrate containing 2 lbs. per gal. technical heptachlor. (1, 4, 5, 6, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindene). Velsicol Chemical Corp., Chicago, Ill.

In the spring of 1957, dieldrin and heptachlor were each applied at 0.5 and 1.0 lb. per acre. Fifteen plots were laid out in a randomized block design, each having an area of 0.01 acre. The materials were diluted to give the required amounts at a spraying rate of 30 gal./acre, and were applied with a power sprayer using a hand gun. Counts were made after 24 and 48 hours, and approximately weekly thereafter until the end of the experiment. The reduction in numbers was calculated by Abbott's formula (Abbott, 1925).

TABLE I

Numbers of live ticks taken by dragging at various intervals in triplicate plots sprayed with dieldrin[1] or heptachlor[2] at two rates per acre on April 8th, 1957. Each plot having been stocked with ten pairs one day before spraying.

| | Untreated | dieldrin | | heptachlor | |
|---|---|---|---|---|---|
| | | 0.5 lb. | 1.0 lb. | 0.5 lb. | 1.0 lb. |
| April 9 | 24 | 25 | 25 | 18 | 12 |
| April 10 | 27 | 14 | 14 | 16 | 18 |
| April 19 | 28 | 7 | 2 | 9 | 3 |
| April 24 | 35 | 3 | 1 | 5 | 1 |
| Percentage Reduction | — | 91 | 98 | 86 | 98 |

## Results and Discussion

In 1956, no ticks were recovered after two weeks in the plots treated with dieldrin at 0.5 lb. per acre, although the initial rate of mortality was low. In 1957, dieldrin and heptachlor at 1 lb. per acre each nearly eliminated the ticks within three weeks.

The low initial rate of mortality may be partly accounted for by the activity pattern of the ticks, since Gregson 1951a) has shown that not all of a given batch of ticks are exposed on the vegetation at any one time. Those exposed at the time of spraying would be reached by droplets of insecticide immediately, whereas the remainder would be affected only by the deposit on the vegetation when they emerged from shelter. For the purpose of the experiment, this treatment is probably adequate, since the period of outdoor recreational activity overlaps only the last week or so of tick activity even in the mountain areas, where the tick season is latest.

## Summary

Dieldrin and heptachlor, sprayed on artificially infested rangeland plots at 1.0 lb. per acre, each reduced numbers of the Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, within three weeks. Lower dosages were less effective.

## Acknowledgment

Grateful acknowledgment is made to the Officer in Charge, Royal Canadian Naval Ammunition Depot, Kamloops, B.C., who made available a very suitable site for the tests.

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# ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART IX—CARIPETA SPP. (Geometridae)[1]

D. A. Ross[2] and D. Evans[3]

*Caripeta* larvae feed on the needles of conifers but no appreciable defoliation by any of the three local species has been recorded in British Columbia. Full grown larvae are about 1½ inches long and may have one or two indistinct dark transverse lines on the front of the head. Body colours are for the most part dull, variable with sometimes obscure brownish X to H markings on the dorsum, darkest along their anterior arms; setae on the upper body arise from small swellings or tubercles that are variable in size. *Caripeta* spp. overwinter as pupae.

**C. divisata** *Wlk.* — *Tsuga heterophylla, Pseudotsuga menziesii, Picea,* all native spp., *Abies lasiocarpa, A. grandis, A. amabilis, Larix occidentalis,* and occasionally on *Pinus monticola, P. contorta* and *Thuja plicata;* a generally distributed species south of latitude 56°; some years it is numerous. LARVA: head pale brown with dark herring-bone markings; body yellowish and grey or brown; interrupted off-white or yellow subdorsal stripes, sometimes obscure; elongate yellow, occasionally whitish, black-edged intersegmental patch anterior to and encompassing each abdominal spiracle; spiracular stripe may be continuous, may in part be suffused with reddish brown; broken yellowish subventral stripes; tubercles prominent; tubercles *ii* on central abdominal segments, black and yellow.

**C. aequaliaria** *Grt.* — *Pseudotsuga menziesii, Pinus ponderosa, P. contorta* (4 records), *P. monticola* (2), *Tsuga heterophylla* (2); Southern B.C. and Southern V.I., much less numerous than *divisata*. LARVA: of dark pigmentation; little whitish or yellowish colour along spiracular area; brownish about the abdominal spiracles.

**C. angustiorata** *Wlk.*—*Pinus contorta*; Central B.C. and Southern interior B.C. LARVA: grey or reddish brown; one specimen with high proportion of black; dorsal stripe usually yellowish; irregular yellowish pleural fold; central abdominal spiracles each narrowly encircled by an unpigmented ring; tubercles *ii* on central abdominal segments black; obscure transverse ridges between tubercles *ii*.

[1] Contribution No. 543, Forest Biology Division, Research Branch, Department of Agriculture, Ottawa, Canada.

[2] Forest Biology Laboratory, Vernon, B.C.

[3] Forest Biology Laboratory, Victoria, B.C.

## Note on a Ground Beetle eating a new-born Field Mouse

This information was given me by Dr. James Bendell of the Department of Zoology.

In July 1958, Dr. Bendell was walking on the south side of the campus by a grassy roadside when he heard the shrill screams of a mouse. Upon locating the sound he found a **Microtus** or vole nest containing several blind suckling young, one of which was being chewed by a male **Carabus nemoralis** Müll. He capture the beetle and the mouse so there was no question as to their identity. The beetle had eaten the back of the thigh and the abdominal wall in the inguinal region so that the body cavity was visible. This beetle is normally a predator on earthworms.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# SPRAYING OPERATION FOR CONTROL OF THE BLACK-HEADED BUDWORM[1], VANCOUVER ISLAND, BRITISH COLUMBIA, 1957

R. R. Lejeune
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During June, 1957, 196,000 acres of western hemlock on northern Vancouver Island, British Columbia, were sprayed to protect stands severely defoliated for two consecutive years by the black-headed budworm. These stands, out of a total outbreak area of about two million acres, were considered to be in critical condition. Surveys indicated that they could expect to receive damaging defoliation in 1957. Although it was dwarfed by the extensive control programs in the western United States and eastern Canada there are some special features about the project that are worth relating.

## Organization

As this was the first large control operation attempted in British Columbia, an organization was needed to plan and direct the project and to provide a legal body for entering into commitments with governmental and private agencies. As a result the British Columbia Loggers' Association formed a permanent Pest Control Committee for this purpose. Representatives from the British Columbia Forest Service and the Forest Biology Laboratory serve on the Committee in an advisory capacity, but since this Association is composed of most of the logging companies in British Columbia, it can be considered that the project was directed by industry. The Forest Biology Laboratory was responsible for spray and biological assessment.

The Committee drew heavily on the experience acquired by other agencies in large-scale operations in the western United States and eastern Canada, but local conditions necessitated modification of some procedures followed elsewhere. We now have an organization and a soundly established pattern tailored to British Columbia conditions for handling future forest insect control problems.

## Spray Equipment and Chemicals

The spraying was done by four converted TBM Gruman Avengers. This was the first time these aircraft have been used for spraying forests in Canada. They were selected because the rugged terrain, the radius of action, and the uncertain weather conditions likely to prevail indicated that a larger aircraft than the conventional Stearman was needed. In our opinion their performance with respect to pay load and spray pattern was impressive. As a result, several of these aircraft have been purchased by a Canadian firm and have been used against the spruce budworm in eastern Canada.

Since it was possible that the infestation could collapse at any time from natural causes, resulting in the cancellation of the operation, raw materials were stored and mixed as needed. Mixing and loading were done at the air base, where a mixing plant was constructed. The plant had a daily manufacturing capacity of about 30,000 gallons of spray and a storage capacity of about 35,000 gallons. Spray was loaded into the aircraft directly from the mixing plant.

The spray consisted of DDT in Standard base oil diluted with diesel oil to yield a solution containing 1 pound of DDT per U.S. gallon with an emulsifier content of 1.64 per cent. The emulsifier was Atlox 2082A. The use of an emulsifier in 1956 (Brown *et al.*, 1958) gave such satisfactory results that it was incorporated into the operational formulation in 1957.

Efforts were made to compare the effectiveness of the operational spray with three other formulations. How-

[1] Contribution No. 528, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

ever, in a pressing mixing and flying schedule it proved unpractical to exercise the precise control essential for experimental tests. Results indicated that as low as one-half pound of DDT per gallon per acre was as effective as the operational solution. Results with diesel oil without emulsifier were inconclusive and plans to experiment with water instead of an oil diluent were cancelled altogether.

### Timing

Black-headed budworm larvae develop more slowly than spruce budworm larvae and therefore provide a longer period for effective spraying. In 1956 it was found that all the larval stages were susceptible to the spray. Spraying can be started when roughly 50 per cent of the larvae are in the second instar and, for maximum effect, should be completed before the appearance of fifth-instar larvae. In 1956 and 1957 this allowed a period of about one month for treatment. Spraying in 1957 commenced on June 10, and despite delays caused by poor weather, was completed on June 20.

### Control Achieved

The operation achieved its principal objective (Lejeune *et al.*, 1957). Biological assessment plots showed that the budworm was completely controlled where the spray deposit was adequate (over 10 drops per $cm.^2$ or .20 gal. per acre). Data obtained indicated that the spray deposit in general ranged from light to medium (1 to 20 drops per $cm.^2$). Deposits were lighter in areas skip-sprayed to avoid lakes, streams, cut-over areas and cedar swamps, and heavier where avoidance of specific landmarks was not required. The indicated average control of about 90 per cent, based on data from five sample plots, was sufficient to prevent serious defoliation in 1957.

### Fish Mortality

When it was decided in the fall of 1956 to proceed with a spraying operation in 1957, it was anticipated that some commercial and game fish might be killed. Accordingly the decision was made known to the Federal and Provincial fisheries authorities, who were invited to have representatives at all subsequent meetings of the Committee.

In co-operation with the Committee, plans were drawn up by the fisheries organizations to assess mortality of fish and fish food organisms. The main concern was for the fry of cohoe salmon and steelhead trout, which would be in the streams during the spray period. To minimize contamination of waters, pilots were instructed to shut off the spray when flying over rivers and lakes, streams were not to be used as boundaries of spray blocks and, where feasible, pilots were to spray parallel to the course of major streams keeping one swath width away. Fisheries representatives, who were present on all flights made by the observation aircraft, were satisfied that a sincere effort was made to implement these measures, but spray drift hit some lakes and streams and fish were killed.

The effects of spraying were measured in nine of the ten major salmon streams in the area (Crouter and Vernon, 1959). Results obtained indicated a large variation in the mortality of cohoe fry, ranging from zero to almost complete annihilation. Losses were severe in four of the major streams, not only to cohoe but also to trout, steelhead yearlings, and possibly alevins of trout and steelhead.

The reduction of aquatic insects paralleled the loss of cohoe fry and the productivity of several streams may not return to adequate proportions for several years.

The effects of spraying varied with each stream but some trends were noted. Fish mortality was high in large streams in flat terrain with dense forest cover, which made the streams difficult to see from low flying aircraft, and in large streams flowing through steep-walled valleys. Mortality was low in streams in well-defined but not particularly steep-walled valleys and in small streams with a dense overhanging canopy.

In June, 1957, 156,000 acres of western hemlock were sprayed to control the black-headed budworm. The operational spray consisted of DDT in Standard base oil diluted with diesel oil to yield a solution containing 1 pound of DDT per gallon with an emulsifier of 1.64 per cent. Spray was applied at the rate of 1 gallon per acre. The indicated average control of about 90 per cent was sufficient to prevent serious defoliation in 1957. Fish populations, particularly cohoe fry, and fish food organisms in some streams were severely depleted.

**Summary**

Although there were a number of puzzling inconsistencies in results obtained from the assessment of fish mortality, it is clear that under the conditions of the operation, fish and fish food populations in some streams were severely depleted.

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## THE DISTRIBUTION OF THE WHEAT MIDGE, SITODIPLOSIS MOSELLANA (Gehin), IN BRITISH COLUMBIA

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A/Provincial Entomologist

The wheat midge, *Sitodiplosis mosellana* (Gehin), was first reported in the Pacific Northwest in 1904 at Chilliwack, B.C. Since that time it appears to have spread through the province. It was listed as an important pest of grain in the lower Fraser Valley in 1905. In 1921 serious damage was reported in the Salmon Arm district. A wheat field was damaged by this pest near Lumby in 1936 when there was also serious damage on Vancouver Island and in coastal districts. Light damage was recorded at Merritt in 1951 and at Nelson in 1953. In 1954 infestations were reported from Larkin, Armstrong and Enderby. Damage occurred on spring wheat at Revelstoke, Grindrod, Enderby and Salmon Arm in 1955.

In 1957 a heavy infestation was examined in a field of Garnet wheat at Kersely, south of Quesnel. According to the farmer this field had been similarly infested in 1956. In 1958 several fields were infested in the Kersely area and serious damage occurred. This infestation appears to be so severe that unless it subsides it is questionable whether the farmers in the area can continue profitably to grow grain. The farmers report that fall wheat and barley as well as spring wheat have been attacked. In the literature, these grains as well as oats are listed as hosts of the pest.

Since the wheat midge has become so well established at Kersely, it seems reasonable to assume that it may eventually move into the Peace River area.

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# AN IMPROVED TECHNIQUE FOR PINNING, SPREADING AND MOUNTING MINUTE LEPIDOPTERA[1]

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Methods of spreading minute Lepidoptera vary greatly, and results are frequently poor. There is no satisfactory board manufactured for spreading their wings, therefore one has been designed by the writer. This paper describes the spreading board and how it is used.

## Construction of Spreading Board

Glue a strip of 2 x 14 x ¼ inch cork to a strip of plywood of the same dimensions. Cut a 1 x 14 inch strip of 1/32 inch thick patent leather lengthwise down the centre, using a straightedge and a sharp knife. Glue the two strips of patent leather 1/32 of an inch apart along the centre of the cork strip, smooth side up. (Fig. 1). It is convenient to make up three or more boards, varying the width of the groove for different sized moths.

## Pinning and Spreading the Moths

The following equipment is used by the writer when preparing microlepidoptera specimens: spreading board, forceps, dental loop, minuten pins, glassine paper in 3/16 x ⅜ inch strips, hard balsa wood pieces ⅛ x ⅛ x ⅝ inches, number 3 insect pins and a standard mounting block.

1. Specimens to be spread must be thoroughly relaxed.

2. Place the moth venter side down on a balsa board. Grasp a minuten pin with a pair of forceps and insert the point perpendicularly through the centre of the thorax, until it penetrates 3/16 of an inch through the venter. The author wears a dental loop to expedite this work.

3. Grasp the top of the minuten pin with the forceps and push it vertically into the groove (which should be just wide enough to fit the insect's body) so that the body rests in the groove, and the wings rest on the board.

4. Very lightly blow the wings forward, separating the fore-wings from the hind-wings. Sometimes they can be blown into the desired position and will remain there without having to be anchored by a minuten pin.

5. Grasp a minuten pin with the forceps and, catching the forewing just behind the longitudinal main vein, close to the thorax, pull the wing forward over the surface of the board until the posterior margin of the hind fringe is at right angles to the body. Anchor it with the pin.

6. Bring the hind wing forward in the same manner until the fringe of the anterior margin is nearly touching the forewing fringe and anchor it.

7. Gently lay a strip of glassine paper lengthwise over the anchored wings, taking care not to disturb any wing scales. With the forceps, secure the strip of glassine paper with four minuten pins, two pins just forward and to the outside of the front wing and two pins just behind and to the outside of the hind wing. Repeat the procedure for the wings on the opposite side.

8. Gently remove the temporary anchoring pins.

9. Using a curved pointed 00 pin in a holder, ease the antennae into the desired position.

10. When the specimen is dry (usually two or three days under room conditions), remove the minuten pins while holding the glassine paper down with a pair of fine forceps.

11. When all anchor pins have been removed, lift the strips of glassine paper with forceps.

12. Using forceps, lift the spread moths from the spreading board.

## Mounting the Moths

Hard balsa wood strips may be ob-

[1] Contribution No. 537, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

tained in 1/8 x 1/8 x 18 inch strips. Cut these into 5/8 inch lengths for mounts. Insert a number 3 insect pin vertically through the balsa mount 1/16 of an inch from one end. Press the mount to a height of 3/4 inch on the pin, using the appropriate step on the "pinning block." With forceps, grasp the pin holding the moth and press the point 1/16 of an inch vertically into the balsa mount 1/8 of an inch from the end. The mounted specimen is then ready for labelling. (Fig. 2).

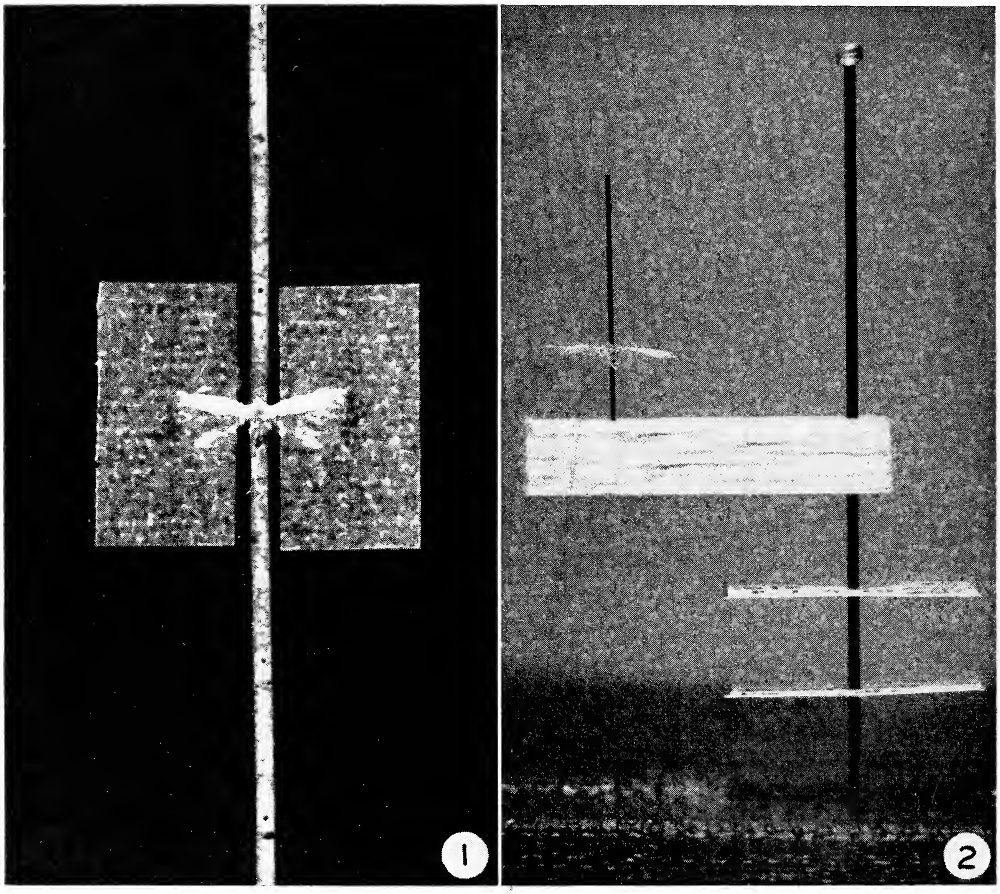


Fig. 1. Moth on spreading board.
Fig. 2. Mounted and labelled moth.

## Pine Siskins Killing Forest Tent Caterpillars

In June 1954 the trembling aspen woodlands along the Fraser River Valley south of Quesnel, British Columbia, were denuded by an outbreak of the forest tent caterpillar, **Malacosoma disstria** Hbn. On June 22 in the semi-open country about Castle Rock, flocks of pine siskins, **Spinus pinus** (Wilson), were numerous and two instances of predation upon the fully-grown larvae were observed. The bird carried a larva to a suitable branch, then standing on the insect's body, grasped the head in its bill and pulled until the viscera were removed. These were laid along the branch and a small portion of the body contents were selected and eaten. One siskin killed three larvae in this manner in a few minutes.

—*J. Grant, Forest Biology Laboratory, Vernon, B.C.*

# AN AUTHENTICATED CASE OF BLACK WIDOW BITE

G. CLIFFORD CARL[1] AND A. W. PERRY, M.D.[2]

In recent years there have been several reported instances in the Victoria area of humans being bitten by Black Widow spiders but in each case, except one, the causative agent was not positively identified. In fact in one instance the victim could not be sure that it was a spider that inflicted the wound and on another occasion it was fairly definitely determined later that the patient received nothing more than a prick from a raspberry cane!

The one known exception involved an eight-year-old boy whose case received some newspaper publicity in April 1950. The spider was apparently identified as a Black Widow but no record of the case has been published.

Another authenticated case of a Black Widow spider bite occurred in Victoria in 1958. The spider was seen immediately following the attack and it was subsequently captured thus permitting positive identification. The victim was a 16-year-old girl admitted to the Royal Jubilee Hospital Emergency Department at 4:15 a.m. on September 9, 1958, suffering with severe abdominal pain. The following is a copy of the case history:

"She had retired on the previous evening feeling well and had wakened at around 3:30 a.m. because of the sensation of a sharp needle-like pain in her right outer lower leg just above the ankle. Pulling her bed covers aside she saw a black spider scurry away. This pain passed off, but was replaced in about fifteen minutes by a severe aching pain in the right groin. This continued, but in turn was replaced in about ten minutes by excruciating generalized abdominal pain of a cramping nature and she was rushed to hospital.

## Physical Examination

When seen shortly after her arrival she appeared apprehensive. Her face was slightly flushed and she was perspiring. She was restless, moving about the stretcher and almost in tears with pain in the abdomen. There was no pain in her leg or groin.

Pulse 90, regular. Blood pressure 140/70. Heart sounds were normal.

The abdomen showed a board-like rigidity. There was muscular but not deep tenderness so that it was apparent that the pain was arising from the abdominal wall rather than from the peritoneal cavity. No abnormality was seen or palpated in the right groin. The right leg showed a small red mark on its lower outer aspect. This could easily have been missed if the girl had not indicated its site. There was no redness or induration at all surrounding the small central red area. The reaction was not even that seen with a mosquito bite.

## Treatment and Progress

It was apparent that her symptoms were due to the bite of a black widow spider. She was given intravenously 10 cc of 10% calcium gluconate a few minutes after her arrival. An ice bag was placed over the site of her bite and a hot water bottle to her abdomen. This resulted in a considerable decrease in her abdominal discomfort and she quietened down considerably but a half hour later it was necessary to give her 1/6 gr. of Morphine subcutaneously and a repeat injection of 10 cc of 10% calcium gluconate intravenously. This resulted in considerable relief of her distress. She was given 1,500 units tetanus antitoxin and antihistamine was commenced (Chlortripolon 4 mg. q.6.h.). During the first 24 hours she was quite miserable with profuse perspiration and the abdominal discomfort was replaced ten hours after admission by an aching in the transverse arches of her feet. She developed no fever and her blood pressure stayed stable. Her

[1] Director, Provincial Museum, Victoria, B.C.
[2] Medical Specialist, Victoria, B.C.

pulse ranged from 90 to 110. She did not void during the first 24 hours and during this period of time it was necessary to give her one further injection of 10 cc of 10% calcium gluconate and three further injections of Morphine gr. 1/6 and two aspirin and Codeine (gr. ½) capsules.

Between the 24th and 48th hour after admission her condition improved. She voided freely. A general urinalysis was negative. The abdominal pain disappeared, but the ache in the feet remained, and the soles of her feet were quite sensitive.

Hyperreflexia was noted at this time and she continued to have a moderate degree of perspiration with chilly sensations but no fever.

On the third hospital day her symptoms disappeared. On the fourth day she was discharged asymptomatic. Examination at this time revealed a soft abdominal wall and normal tendon reflexes.

**Final Diagnosis**

Black Widow Spider Bite (Arachnoidism).

The Black Widow spider is found in the dry regions of the Province usually in rubble heaps or under rocks. It is locally common in the Okanagan Valley and extends its range west at least as far as Princeton. Some years ago it was abundant in the vicinity of Trail (see The Black Widow Spider by K. Raht, Rept. Prov. Mus. for 1943, p. 13 and also Publication No. 127, by Fergus J. O'Rourke, Canada Department of Agriculture, Science Service, 1953). On Vancouver Island it is relatively common in the Victoria area and is found along the east coast as far as Nanaimo. On the mainland it has been collected at Powell River which seems to be an unusually wet place for this species.

In the southern United States this spider is said to be much more venomous yet fatal cases affecting man are rare.

## ACHAETONEURA DATANARUM REARED FROM ANTHERAEA POLYPHEMUS IN BRITISH COLUMBIA (Diptera: Tachinidae)

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and

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A larva of *Antheraea polyphemus* (Cramer) was observed feeding on *Betula occidentalis* at Vernon, B.C., in July, 1945; it spun its cocoon in mid-August. The cocoon was brought indoors on January 30, 1946, and placed in an incubator next day (72° F., 90% relative humidity). On February 19, sixteen dipterous larvae emerged from it and formed puparia. From March 4 to 7, seven male and nine female flies were recovered. They have been identified by Mr. A. R. Brooks as *Achaetoneura datanarum* (Townsend, 1892), a somewhat uncommon species.

A second cocoon, from Trinity Valley, B.C., was incubated from March 12 to April 8 inclusive. Fifteen dipterous larvae left it on April 8 and formed puparia. On April 20-22, eight males and six females of *A. datanarum* emerged (det. Brooks); one additional specimen was accidentally destroyed before sexing.

Both cocoons were rested on a support which was at a 45° angle in the rearing jar. In each case the fly maggots emerged from the valvular end, though in one instance this end was upward.

# SOME PROBLEMS IN THE COMPILATION OF A COMPATIBILITY CHART OF ORCHARD SPRAY CHEMICALS FOR USE IN BRITISH COLUMBIA[1]

D. P. Pielou[2]

This paper arises out of discussions that took place when the compatibility chart of spray chemicals for orchardists in the British Columbia interior was drawn up in 1957; I was secretary of the committee responsible for producing the chart. This chart has to be revised at intervals, though not necessarily annually, as new materials and new formulations are introduced, and so it is worthwhile trying to put on paper some of our thoughts as to the principles involved.

In this paper, therefore, the examples quoted relate almost solely to experience in British Columbia while the opinions expressed represent an attempt by the author to summarize his own conception of the substance of numerous discussions between members of the Summerland Entomology Laboratory and of other agricultural scientists concerned with fruit growing in British Columbia. A review and discussion based on a broader geographical basis, perhaps world-wide, and on a broader range of crops, would be most desirable. This, however, would represent a much more ambitious project than is intended here.

One of the first things to appreciate about "compatibility" in connection with spraying of pesticides, is that the word covers a number of criteria and that materials that are compatible according to one criterion, are not compatible according to another. Compatibility of spray material is not a relatively simple concept as is "compatibility" of rootstock and scion in horticulture.

## Chemical Compatibility

Primarily, compatibility is thought of as chemical compatibility, e.g., if two chemicals react in such a way as to reduce the effectiveness of one or both, then the two chemicals are incompatible. Thus, if certain fungicidal copper compounds are mixed with lime-sulphur (a mixture of calcium polysulphides) copper sulphide is formed which is insoluble, and useless (37). However, in general, the changes that take place on mixing spray materials may be very complex and even purely chemical compatibility can turn out to be a complex matter. In practice, a spray chemical does not consist of one compound, but is a "formulation." The need for formulation arises from the fact that most of the newer miticides, insecticides and fungicides are insoluble in water (20) and water is the vehicle most commonly used in applying them. They may be, therefore, sold dissolved in organic solvents such as xylene to which a small amount of emulsifier, such as an alkyl aryl polyether alcohol, is added (36). When mixed with water in the tank of the sprayer, such a formulation forms an emulsion. Alternatively, the active ingredient may be mixed with a suitable finely-divided, inert carrier acting as an absorptive material because of the large surface area of the fine particles (for example, aluminum magnesium silicate) together with a small amount of wetting agent such as an alkyl phenyl ether of polyethylene glycol (6). The formulation is sold as a co-called "wettable powder" which, on mixing with water in the spray tank, becomes a suspension of limited stability that is prevented from settling mainly by mechanical agitation. Since the type of formulation influences the effectiveness of the pesticide (10) it is obvious that on mixing two formulations, the possibilities for chemical and physical reactions that will affect the performance of one or both of the pesticides are complex. Generally speaking, chemical compatibility is, in practice,

[1] Contribution No. 2, from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Entomologist.

the compatibility of materials that are already mixtures. It is not so simple as saying that sodium chloride and silver nitrate are incompatible because the insoluble silver chloride is percipitated.

There is another problem—a practical one—of chemical incompatibility. Chemists may say definitely that two materials are incompatible because they decompose during or after mixing. However, in practice the rate of decomposition is exceedingly important. Thus, according to McArthur and William (25), parathion [*O,O*-Diethyl O-*p*-nitrophenyl phosphorothioate] breaks down extremely slowly when mixed with lime-sulphur in the laboratory. If a tankful of the mixture is sprayed without unreasonable delay, both materials are effective. On the other hand, malathion [S-(1,2-Dicarbethoxyethyl)-*O,O*-dimethyl phosphorodithioate] breaks down so rapidly in lime-sulphur that only 25 per cent of the malathion remains as such approximately one hour after mixing (25). From the grower's point of view, as well as the chemist's, these two materials are incompatible. All so-called organic phosphates will, in time, break down in alkaline solutions like lime-sulphur, but it is the rapidity of breakdown that is important.

Malathion deserves further mention. It hydrollyses very easily, not only in alkaline solution but even in acid, and, to some extent, in water (20). In the presence of iron the hydrolysis is catalysed to such a degree that malathion emulsion must be sold in glass, and not in iron containers (20). The ease of hydrolysis makes production of wettable powders of malathion particularly difficult. This is why malathion is an expensive material to formulate as a wettable powder and costs more than parathion. The emulsion form in glass bottles is generally cheaper.

Mention should also be made of nicotine as used in British Columbia. Nicotine sulphate is acid, and, on most charts therefore, indicated as compatible with organic phosphates. However, it was found that, under conditions of the British Columbia interior, nicotine sulphate could be made a more effective aphicide by the addition of sodium carbonate, which reacts with nicotine sulphate to release free nicotine. At temperatures above 70°F., and particularly when applied as a concentrate spray by an air-blast machine, nicotine is extremely toxic to aphids (23). However, nicotine sulphate-sodium carbonate mixture is alkaline and should not be used with organic phosphates or with other pesticides that break down in alkaline solution (25).

Some of the so-called minor elements—zinc, manganese, magnesium, boron—can be applied as dissolved salts with an orchard sprayer to nutrition-deficient trees. Soluble dinitro compounds such as sodium dinitro-*O*-cresylate, if added to such salts, tend to react to produce insoluble metallic compounds that are unavailable to the plant and are but slightly toxic to insects. However, the two types of materials are not applied at the same time (2).

This brings up a point for discussion. Why express an opinion on the compatibility of two materials that should never be applied at the same time? Some comprehensive charts show compatibilities, or otherwise, of highly unlikely mixtures. We feel it is better to discourage the grower from wasting money and risking damage from the use of such mixtures by indicating that the two materials are not normally applied together.

## Phytotoxic Incompatibility

When some pesticides are mixed, no chemical change may take place that reduces the effectiveness of the ingredients, but the mixture may cause damage to the plant. This is often a physical phenomenon in that the solvent, or adjuvant, in one formulation may allow increased pentration of some component in the other formulation. Many oils, for instance, readily penetrate the underside of a leaf particularly through the stomata (11) and so transport anything dissolved in them. Lighter oils will readily penetrate either leaf surface and twigs as well (40). It is not surprising, therefore, that many oils do damage to fruit trees (5) and the selection of suitable types of oils, for both dormant and summer spraying, occupied the attention of orchard entomologists for many years. Thus, summer oil can cause plant damage, and so can wettable sulphur, but a combination of the two is far worse than one would expect from a purely additive response. This effect of this particular combination is so marked (12) that some of our older spray calendars, published at a time when application of summer oil was more common, included a warning not to apply sulphur (or lime-sulphur) and summer oil, even separately, within a certain time in order to avoid spray injury (1). In place of the summer oil, any organic solvent from another formulation can act with sulphur in the same way. The high toxicity of DNOC [2-methyl-4, 6-dinitrophenol] is well known (5, 20) and, though it could be used by itself with care as a summer spray in orchards (26), it has not been so recommended because the presence of a very small amount of oil, as in spray-drift from a neighbors orchard (9), or the presence of slight oil residue from a much earlier spray application (29), will produce severe symptoms of phytoxicity. And oil or oil-like components in formulations of other pesticides act similarly on DNOC. Incidentally, such deep penetration of contact insecticides is, generally speaking, of little value insecticidally as most insects or mites, or their eggs, are on the surface of the plant.

We have, for instance, listed malathion as incompatible with dinitro compounds because malathion is marketed most cheaply as an emulsion, and the solvent in the emulsion allows the dangerous penetration of the dinitro compound. Malathion emulsion in combination with glyodin [2-Heptadecyl-2-imidazoline acetate] and captan [N-Trichloro-methylmercapto-4-cyclohexene-1, 2-dicarboximide] appears to be more phytotoxic than a purely additive response would imply. Sevin [N-methyl-1-naphthyl carbamate] and lime-sulphur are incompatible because, in alkaline solution, the former breaks down fairly rapidly to alpha-napthol (39) which is decidedly toxic to some apple varieties, although Sevin itself is not. There is also some slow breakdown of Sevin alone to alpha-napthol because of weathering and this has caused slight injury on some varieties of apple, e.g., McIntosh (39).

A somewhat similar case, though not of phytotoxicity, is the evidence (33) that tainting from lindane [1,2,3, 4,5,6-hexachloro-*cyclo*hexane] is accentuated in the presence of summer oil, added to increase the aphicidal properties (27), presumably a result of increased penetration.

On the other hand, damage with minor elements probably is rarely accentuated by incompatibilities for the damage is believed to be due to exosmosis and would take place with any strong salt on the leaf.

In some combinations that are prone to cause damage, for instance ovex [p-Chlorophenyl *p*-chorobenzenesulphonate] with malathion, or with ferbam [ferric dimethyldithiocarbamate], there is no evidence, considering the extent of the damage, that more than a purely additive response is involved (9). However, even in such a case, some warning to the grower is required. It seems unlikely that in a mixture of ingredients, all phytotoxic to some degree, overall phytotoxicity will be reduced.

## Physical Incompatibility

An example of physical incompatibility arises in the mixing of lime-sulphur and dormant oil. If oil that is emulsified by a soap or soap-like compound is added to a solution of lime-sulphur, the calcium in the lime-sulphur reacts with the emulsifier to produce a calcium soap and may cause the emulsified oil to invert. In that case there will be an emulsion of water drops in oil instead of oil drops in water; and, because the continuous phase is oil, the emulsion will float on top of the bulk of the water as a scum (19).

At this point, before considering other aspects of compatibility, it is worth noting that manufacturers seem to be conservative when describing the compatibilities of a new material. Though they may well tend to exaggerate its pesticidal potencies, they have nothing to gain by risking its being mixed in some deleterious combination that may merely bring their product a bad name. This means that the grower may have to make separate applications in order to avoid stated incompatibility and so he incurs unnecessary expense. However, from the manufacturer's point of view, a product is not usually sold on the strength of its wide compatibility; it is sold on reputed efficiency in killing disease organisms or insect pests. For instance, DDT is often stated to be incompatible with lime-sulphur, but the actual decomposition is so slow as not to be a factor.

## Other Spraying Problems

The categories of incompatibility that have been lisited above are conventional ones, and the necessary information can generally be included in some way, in the conventional type of two-dimensional chart. There are, however, closely related problems of spraying which usually need to be dealt with at the same time, but which do not solely concern combinations of two or more spray materials. We can, if we like, stretch the word "incompatibility" to include these problems; but, whether we do or not, these problems should be discussed at the same time.

(a) Some questions arise from the use of a particular type of sprayer. We might refer to these as problems of "m e c h a n i c a l incompatibility." Thus, in the air-blast concentrate sprayer, difficulties of excess foaming sometimes arise, difficulties that do not arise in the old-type, high-volume, gun sprayers. For instance, Sulphenone [p-chlorophenyl phenyl sulphone] has to be applied at high rates for mite control (2, 7). As DDT [2,2-Bis(*p*-chlorophenyl-1, 1, 1-trichloroethane] and perhaps ferbam, are likely to be applied at the same time (2), the total quantities of emulsifiers and wetting agents in the tank are very large; excessive foaming is the result (25). The material, ryania (ground stems of *Ryania speciosa* Vahl.), has caused trouble simply by the concentration of solid suspension in the tank. For instance an application of ryania at 48 pounds per acre for codling moth control in British Columbia (28) meant that there were 48 pounds of insoluble and bulky powder in 80 gallons of water. DNOCHP [2,4-dinitro-6-*cyclo*hexyl p h e n o l] formerly recommended for the control of several species of mites (1) is one of the few spray chemicals unsuited for concentrate application because of enhanced phytotoxicity (7). On the other hand, under some circumstances phytotoxicity is reduced by true concentrate application (i.e., no leaf drip as compared with dilute high-volume application for the same per acre amount of material (21, 23).

(b) "Seasonal Incompatibility". Many materials are safe at one stage of plant development, but liable to cause damage at another; dormant oils are an obvious example. Ovex is ovicidal at the pink bud stage, and in the summer, but because of the likelihood of fruit damage (8), can only be recommended in the former case. Other miticides such as Aramite [2-(*p*-tert.-Butylphenoxy)-isopropyl 2'-chloroethyl sulphite] are non-ovicidal and would be of little value in the early part of the season (7).

(c) "Weather Incompatibility". Dinitro compounds and lime-sulphur must dry quickly if injury is to be prevented. That, in fact, is the reason that lime-sulphur is applied in England by concentrate sprayer, completely undiluted (23). The general recommendation in British Columbia is not to apply lime-sulphur spray concentrate when leaves are wet (2).

In warmer climates, wettable sulphur can cause injury to many crops (19) and in British Columbia is likely to do so to fruit-tree foliage during hot summers. For many years the spray calendar (1, 2) has contained a warning to this effect.

At high summer temperatures nicotine is a very effective aphicide but in cool weather it gives poor aphid control in orchards (21, 24, 34).

(d) "Crop and Variety Incompatibility". Some crops or varieties are particularly likely to suffer damage from a particular spray chemical regardless of whether it is combined with other materials. For instance, malathion is likely to damage cherry, either as a wettable powder or as an emulsion (34). Diazinon [O, O-Diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate] is generally safe on cherry as a wettable powder, or an emulsion (31), but under the moister conditions of the Kootenay district, the latter has caused damage (38). Aramite is safe on apples but can cause damage on pears (2, 7). Pears, especially of the Anjou variety, are also more susceptible to injury from dinitrophenol derivatives than apples (26). Lead arsenate, once widely used on apples, is phytotoxic to peach and apricot (35). Maneb may be injurious to some varieties of apples, particularly Rome Beauty. Golden Delicious apple is susceptible to injury by many materials, for instance, by trithion [O, O-Diethyl *S*-*p*-chlorophenylthiomethyl phosphorodithioate] either as an emulsion or wettable powder (32). Fruit damage is a particularly important consideration because sales organizations demand a very high standard of finish and a freedom from blemish—a problem not met with in many other crops.

(e) "Geographical Incompatibility". This is perhaps a vague category because not only climate varies with geographical locality, but so do soil, orchard practices, varieties, times of application, species of pests and types of applicator. However, it is clear that some general differences are important. Thus, lime-sulphur and oil are applied regularly to peaches in California, but used in British Columbia the same mixture would cause damage (35) and is not recommended (2). Rapidity of drying in different localities may influence the choice of spray chemicals. Characteristic varieties in different localities may cause different materials to be regarded as safe or dangerous. In England, certain apple varieties including Worcester Pearmain and James Grieve (30), are seriously damaged by the mite ovicide, fenson [*p*-Chlorophenyl benzene sulphonate] in the pink bud stage (18). However, fenson is not injurious at the pink bud stage to common varieties of apple in British Columbia and is here regarded as less likely to cause damage than the somewhat chemically similar ovicide, ovex (8).

The preceding examples in this section are examples of difficulties arising from spraying that are not, strictly speaking, the result of incompatibility; but they emphasize that the grower must concern himself with all troubles associated with spraying, and incompatibility, as ordinarily defined, is one of these. The grower wants to know if he will get effective control and no damage from chemicals A or B; or from a mixture of A and B, irrespective of whether conventional conceptions of compatibility are involved. Therefore, along with a suitable local compatibility chart, there should be a brief summary of general and specific advice about dangers that are not apparent from inspection of the chart alone. This summary should be regarded as equally important to the chart. Without it a grower may be inclined to regard the chart as a complete guide to the dangers associated with spray mixtures; this it certainly is not.

## Presentation for the Grower

When we have acquired all the data we think relevant, we are next faced with the problem of presenting the information to the grower. We do not think that a broad, comprehensive compatibility chart covering all crops, areas, and chemicals is of any great value. Such a chart must have so many reservations and warning categories as to be of doubtful value except in the most obvious cases. Moreover, a large compatibility chart cov-

## COMPATIBILITY CHART

FOR SPRAY CHEMICALS USED ON TREE FRUITS IN B.C.

1958

| | DDT | DIAZINON | MALATHION | LINDANE | NICOTINE SULPHATE + WASHING SODA | FENSONE | ARAMITE | SULPHENONE | OVEX | DORMANT OIL | DORMANT OIL + DNC | DINITRO CRESOL SODIUM SALT | DNP | LIME SULPHUR | WETTABLE SULPHUR | BORDEAUX | FERBAM | ZIRAM | MANEB | DICHLONE | MANGANESE, BORON AND MAGNESIUM | KELTHANE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DDT | | ▒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ▒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| DIAZINON | ✓ | | ▒ | ▒ | ▒ | ▒ | ✓ | ✓ | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ✓ | ▒ | ✓ | ✓ | ✓ | NO | ✓ | ✓ |
| MALATHION | ✓ | ▒ | | ▒ | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | NO | NO | NO | ✓ | ▒ | O | O | O | ✓ | O | ✓ |
| LINDANE | ✓ | ▒ | ▒ | | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | NO | ✓ | NO | ✓ | NO | NO | NO | NO | ✓ | ▒ | ✓ |
| NICOTINE SULPHATE + WASHING SODA | ✓ | ▒ | ▒ | ▒ | | ▒ | ▒ | ✓ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ▒ | ▒ | ▒ | ▒ | ✓ |
| FENSONE | ✓ | ▒ | ✓ | ✓ | ▒ | | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ✓ | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ |
| ARAMITE | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | NO | ✓ | NO | ✓ | ✓ | ✓ | ▒ | ✓ | ▒ |
| SULPHENONE | ✓ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ▒ | ✓ | ▒ |
| OVEX | ✓ | ▒ | ✓ | ✓ | ▒ | ▒ | ▒ | ▒ | | ▒ | ▒ | ▒ | ▒ | ✓ | ✓ | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ |
| DORMANT OIL | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | | ▒ | ✓ | ✓ | ✓ | ▒ | NO | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| DORMANT OIL + DNC | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| DINITRO CRESOL SODIUM SALT | ▒ | ▒ | NO | NO | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ▒ | | ▒ | A | ✓ | NO | ✓ | ▒ | ▒ | NO | ▒ | ▒ |
| DNP | ✓ | ▒ | NO | ✓ | ▒ | ▒ | ▒ | ▒ | ▒ | ✓ | ▒ | ▒ | | NO | ✓ | NO | NO | NO | NO | NO | ▒ | ▒ |
| LIME SULPHUR | ✓ | ✓ | NO | NO | ▒ | ✓ | NO | ✓ | ✓ | ✓ | ▒ | A | NO | | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | NO | NO |
| WETTABLE SULPHUR | ✓ | ✓ | ✓ | ✓ | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ✓ | ✓ | ▒ | | ▒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| BORDEAUX | ✓ | ▒ | ▒ | NO | ▒ | ▒ | NO | ✓ | ▒ | NO | ▒ | NO | NO | ▒ | ▒ | | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| FERBAM | ✓ | ✓ | O | NO | ✓ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ✓ | NO | ▒ | ✓ | ▒ | | ▒ | ▒ | ▒ | ✓ | ✓ |
| ZIRAM | ✓ | ✓ | O | NO | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ▒ | NO | ▒ | ✓ | ▒ | ▒ | | ▒ | ▒ | ✓ | ✓ |
| MANEB | ✓ | ✓ | O | NO | ▒ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ▒ | NO | ▒ | ✓ | ▒ | ▒ | ▒ | | ▒ | ✓ | ✓ |
| DICHLONE | ✓ | NO | ✓ | ✓ | ▒ | ✓ | ▒ | ▒ | ✓ | ▒ | ▒ | NO | NO | ▒ | ✓ | ▒ | ▒ | ▒ | ▒ | | ▒ | NO |
| MANGANESE, BORON AND MAGNESIUM | ✓ | ✓ | O | ▒ | ▒ | ▒ | ✓ | ✓ | ▒ | ▒ | ▒ | ▒ | ▒ | NO | ✓ | ▒ | ✓ | ✓ | ✓ | ▒ | | ✓ |
| KELTHANE | ✓ | ✓ | ✓ | ✓ | ✓ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | NO | ✓ | ▒ | ✓ | ✓ | ✓ | NO | ✓ | |

✓ GENERALLY COMPATIBLE.

NO DO NOT USE TOGETHER. EITHER CAUSES DAMAGE, OR SPRAY IS INEFFECTIVE, OR REDUCED IN EFFECTIVENESS.

O WIDELY USED, OR LIKELY TO BE WIDELY USED, AS A MIXTURE; GENERALLY SATISFACTORY BUT DAMAGE OCCASIONALLY OCCURS.

A COMPATIBLE WHERE DNC IS USED FOR SPRAY THINNING, BUT DNC IS INEFFECTIVE FOR INSECT CONTROL IN THIS MIXTURE.

▒ NOT APPLIED AT THE SAME TIME, OR ON THE SAME FRUITS, OR UNNECESSARY TO USE BOTH CHEMICALS.

Fig. 1.—Compatibility chart of orchard spray chemicals for use in British Columbia.

ering many more chemicals than are used in British Columbia will merely confuse the grower; consequently, the chart, or charts, should be as simple as possible. In some fruit growing areas where many chemicals are in use, some simplification has been reached by issuing charts for each tree-fruit. This has been done, for instance, in New Zealand by Jacks and associates (14, 15, 16). Borden (4) in California produced a compact chart of reasonable size covering all tree-fruits and nuts, but consisting of two sections—one covering dormant and prebloom sprays, and the other post-blossom applications. Both the New Zealand and California charts covered a larger number of chemicals than are used in British Columbia. In addition to the charts for specific fruits, Jacks (13) also issued a booklet giving general warnings on incompatibilities for all crops.

Examination of the present British Columbia spray recommendations for orchardists (2), shows that 11 materials are listed for use as sprays on cherries, ten on prunes, eight on apricots, 16 on peach, and 19 on apples and pears. These, of course, include alternatives; only a few would be used by any one grower. All materials that can be applied to stone fruits can be, with only one or two exceptions, applied to apples. And in addition, almost all fruit growers in the British Columbia interior grow apples, though not all grow stone fruits. About five materials, not on the 1958 spray chart, are also in fairly common use. In view of the modest number of materials recommended in British Columbia, it was felt that one chart could cover all tree-fruits. Separate smaller charts for each stone fruit would not be justified because very few growers earn a living from one kind of stone fruit only.

A decided stand was taken to express no opinion on the compatibility of materials not used together, but to insert a symbol on the chart indicating "not applied at the same time, or on the same fruits, or unnecessary to use both materials". This approach should help the grower to avoid error and expense in the use of a wrong, or unnecessary material, and discourage him from using unusual mixtures that might damage his fruit.

The category "spray with caution" so prevalent on many comprehensive charts, we consider to be almost useless. If a grower could detect, within a few minutes of commencing to spray with some questionable combination, any plant injury or lack of pest control, and could thereupon discontinue his efforts, there might be some point in the warning. However, in practice, the effectiveness, or damage that results, is not, as a rule, apparent until several days later. When there is reasonable likelihood of damage, we feel that the materials should be listed as incompatible. Now that rapid application by concentrate sprayer (23) is common it is then well worth the grower's time to put on separate spray applications rather than risk damage. On the rare occasions when a grower might be likely to use a doubtful mixture and take a calculated risk, the possibility of damage would be indicated.

A compatibility chart based on considerations of this kind was issued in 1957 (3). Since then, a few extra materials have been added to the list and the extent of the use of others enlarged. A modified chart incorporating these recent changes is shown in Fig. 1. In this chart all currently recommended spray materials are listed. In addition, older materials, though not recommended but widely used, are also included. Obsolete materials still used by a few growers are not listed, nor is the highly toxic compound, parathion, though it is quite commonly applied. As it is the firm, if unique, policy in British Columbia not to recommend highly toxic materials (21) particularly because of dangers to human beings in the typically small orchards and in home sites, it was considered that nothing further should be done to apparently sanction the use of such materials.

## General Advice on Spraying and Compatibility

Under the heading "Information on

Compatibility, Spray Damage and Related Problems", information, of the type mentioned earlier that covers points not apparent from the chart, was noted on the back of the chart issued in 1957. Since then a number of omissions have been noted. The following items of information, and recommendations for growers, are suggested for the next chart to be issued:—

1. Lack of "compatibility" may be apparent in several ways. Combinations are incompatible (a) if they cause damage when the separate ingredients do not (b) if the combination causes a reduction of effectiveness of either ingredient (c) if there are other troubles such as excess foaming in the tank, or breaking of an emulsion, that make spraying difficult.
2. Almost all spray materials may, under unfavourable conditions, cause injury.
3. Unrecommended combinations may sometimes be harmless or satisfactory. They may also be disastrous.
4. Some spray materials are prone to cause injury; in a combination this may be confused with incompatibility.
5. Under British Columbia conditions, emulsions or solutions are generally more likely to cause damage than wettable powders. In combinations this tendency may be increased.
6. Liquid surface-active adjuvants or "surfactants" (in excess of the normal adjuvant in an emulsion or wettable powder), added by growers to spray concentrates to improve finish and effectiveness, are likely to accentuate injury from materials that are themselves prone to cause injury; or if spraying is continued, to dripping; concentrates containing ferbam, malathion, DNOCHP, or lime-sulphur are particularly suspect in this connection.
7. Once a tank of spray material is mixed, apply as soon as possible.
8. Do not spray potentially harmful materials when foliage is wet.
9. Spray in still air if possible.
10. Excess foaming may occur in the tank if several materials are mixed, as each may contain a highly-foaming wetting agent. Certain types of wettable sulphur are liable to foam excessively in concentrate sprayers.
11. Dormant oil may cause injury to fruit buds if applied too late, and particularly if improperly emulsified or double-sprayed. Application in windy conditions may result in double spraying.
12. Malathion should not be used on cherries. On other fruits, a wettable powder is less likely to cause injury alone, or in mixtures, than are liquid formulations. Malathion decomposes very rapidly in alkaline solutions such as lime sulphur, and becomes ineffective.
13. Nicotine sulphate should always be used with washing soda for maximum effectiveness in concentrate spraying. This is a basic, not acid, mixture and incompatible with many other materials. Most compatibility charts refer to the use of nicotine sulphate alone; it is acid, and behaves differently.
14. Nicotine should not be applied at temperatures below 70°F. or ineffective control may result.
15. Lindane is not now recommended because of its tendency to taint fruit, especially processed fruit.
16. Aramite should not be used on pears*.
17. DNOCHP should not be applied (a) with concentrate sprayers (b) to pears until four weeks after the calyx stage (c) to apples until two weeks after the calyx stage (d) with summer oil or after oil (e) with added surface-active adjuvants. DNOCHP may react with basic or metallic compounds.

*This was the recommendation up to 1958. Because of a possible carcinogenic hazard, the Canadian Food and Drug Directorate prescribed, early in 1959, a legal residue tolerance of zero for Aramite. Aramite is not now recommended at all in British Columbia.

18. Lime-sulphur should not be applied as a concentrate when trees are wet, or in damp weather.
19. Ovex and fenson should not be applied after the pink bud stage to any fruit.
20. Maneb can cause injury to apples of the Rome, Cox's Orange and Wagener varieties.
21. Ferbam leaves a more objectionable residue than ziram. Husk fall application of ferbam to stone fruits must not be delayed or unmarketable fruit may result from discoloration.
22. The information presented in the chart refers to two-ingredient sprays. If three or more ingredients are mixed, unpredictable incompatibilities may occur. The more materials there are in the tank the greater is the probability of trouble.
23. Do not exceed recommended speeds when using a concentrate machine.
24. "Semi-concentrate" spraying is more dangerous than concentrate spraying. Contrary to popular opinion "semi - concentrate" spraying, i.e., from 90 to 250 gallons of spray liquid per acre, is more likely to result in spray injury than true concentrate spraying, i.e., less than 75 gallons per acre, from a similar machine. That is because "semi-concentrate" spraying results in extensive dripping and, with spray materials several times stronger than in gun spraying, injury is likely to occur at the point of drip on leaves or fruits. If a concentrate sprayer is properly designed and adjusted there is no drip at an output of 75 gallons per acre or less.
25. Improper adjustment of concentrate sprayers can cause damage. It is most important that concentrate sprayers have air volume and air velocity adequate to spray the tops of trees without overspraying the bottoms of the trees. Overspraying with a true concentrate sprayer can be recognized by the occurrence of drip. Sometimes overspraying is the result of wrong nozzle arrangement and sometimes of worn orifice discs or swirl plates. Nozzles should be adjusted so that about 75 per cent of the spray liquid is in the upper half of the air stream.

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## A Solpugid in British Columbia

A couple of specimens of this near relative of spiders were given me some years ago by a student from southern Alberta. In these animals the head is distinct from the rest of the body and their classification depends upon the teeth in the upper part of the mandibles of the males. On February 14, 1958, Mr. W. Preston, R.R. No. 1, Oliver, in the South of the Okanagan Valley, brought me a solpugid which he had collected in June 1956 near an irrigation ditch. It is a female and so cannot be classified. I think this is the second record of a solpugid being taken in British Columbia. Mr. Jim Grant of Vernon, informed me that Dr. Kurata of the Royal Ontario Museum had reported them some years ago.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# CONTROL OF APHIDS AND CATERPILLARS ON BRUSSELS SPROUTS IN BRITISH COLUMBIA

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The cabbage aphid, *Brevicoryne brassicae* (L.), is a serious pest of brassica crops in British Columbia. The recommended control measures with malathion and TEPP have not always been satisfactory, especially on Brussels sprouts, broccoli, and cauliflower. With new and potentially useful systemic and contact insecticides available or about to become available it was necessary to work out new recommendations. This paper reports the results of exploratory field tests conducted at Vancouver in 1958.

Brassica crops are also attacked each season by other pests, which were considered when evaluating the insecticides against cabbage aphid; these were: imported cabbageworm, *Pieris rapae* (L.), diamond-back moth, *Plutella maculipennis* (Curt.), cabbage looper, *Trichoplusia ni* (Hb.), and green peach aphid, *Myzus persicae* (Sulz.).

## Methods and Materials

Brussels sprouts was used as the test crop since it presented the most difficult problem in control under B.C. conditions. The aphids get into the sprouts where they are shielded from sprays and dusts. It lends itself well to continuing appraisal of leaves and of the harvested product. This crop also has a long growing period and must be protected until harvest is complete, which may be in November or even later.

Cultural procedures followed those of commercial growers as closely as possible. The variety of Brussels sprouts used was Long Island Improved, the one most commonly grown in the area. Plants were started in the seedbed May 8 and transplanted to the field June 12. The seedbed and the plants at transplanting were treated with heptachlor dust to control root maggots.

Eight treatments and the check were replicated 4 times in randomized blocks. Each plot consisted of two rows of 10 plants each. Table I shows the insecticides, formulations, rates per acre per application, and dates of application. Di-syston granules were applied to the soil around the base of the plants, but the other insecticides were applied as sprays at the field scale rate of 100 gallons per acre with a compressed air sprayer. The method of spraying gave results similar to those that would have been obtained in field applications: the spray nozzle was directed above and beside the plants but the rate did not permit individual spraying of each plant or thorough coverage of the lower leaves, especially the undersides. The surfactant Triton B 1956 (Rohm & Haas Co., Philadelphia 5, Pa.) was added to each spray at the rate of 4 ounces per 100 gallons. Portable barriers (figures 1 and 2) were placed around the plots during spraying. These were made of 1 x 4 inch cedar with corner braces, and covered with sign cotton cloth as used for advertising.

Di-syston was first applied when the aphids appeared in the field. The first application of all other materials was on July 30, when there were 194 colonies of *B. brassicae* on 60 leaves, i.e. when the infestation was well established.

Counts were made 14 times at weekly intervals from August 8 to November 14 from an upper, a middle, and a lower leaf from each of 5 plants at random per plot. Data recorded were: numbers of colonies of cabbage aphids, numbers of adult green peach aphids, numbers of each of the 3 species of caterpillars, and estimates of the percentage of leaf surface dam-

[1] Contribution No. 12.

**TABLE 1.—Treaments against cabbage aphid on Brussels sprouts at Vancouver, B.C., 1958.**

| Insecticide | Toxicant per acre, per application lb. | Treated |
|---|---|---|
| None — check | — | — |
| TEPP[1] 20% emulsion | 0.25 | July 30, Aug. 12, 25, Sept. 5, 15, 22 |
| malathion[2] 57% emulsion | 1.25 | July 30, Aug. 12, 25, Sept. 5, 22 |
| Thimet[2] 47.5% emulsion | 1.00 | July 30, Aug. 18, Sept. 15 |
| N.A. Cyanamid 12,880[2] 46% soluble conc. (Dimethoate) | 1.00 | July 30, Aug. 25 |
| N.A. Cyanamid 18,706[2] 25% soluble conc. | 1.00 | July 30, Aug. 18, Sept. 15 |
| Di-syston[3] 5% granules | 1.00 | July 7, 30, Sept. 2 |
| Systox[3] | 0.50 | July 30, Aug. 25 |
| Phosdrin[4] soln. | 0.45 | July 30, Aug. 12, 25, Sept. 8, 22 |

1 Later Chemical Co., Vancouver 14, B.C.
2 Cyanamid of Canada Ltd., Toronto 5, Ont.
3 Chemagro Corp., New York 16, N.Y.
4 Shell Oil Company of Canada, Toronto 1, Ont.; 12.3 lbs. of toxicant per gallon.

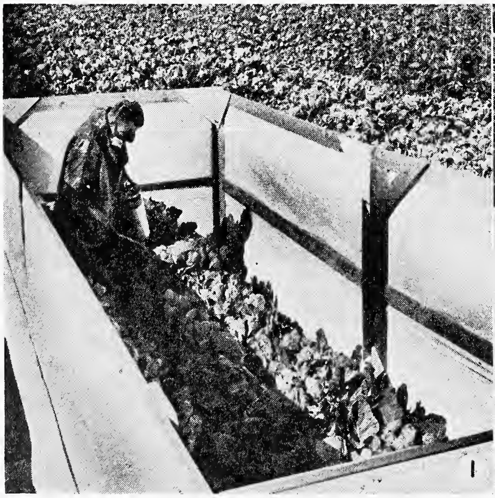

Fig. 1.—Portable barriers around plot during spraying.

Fig. 2.—Portable barriers being assembled around plot.

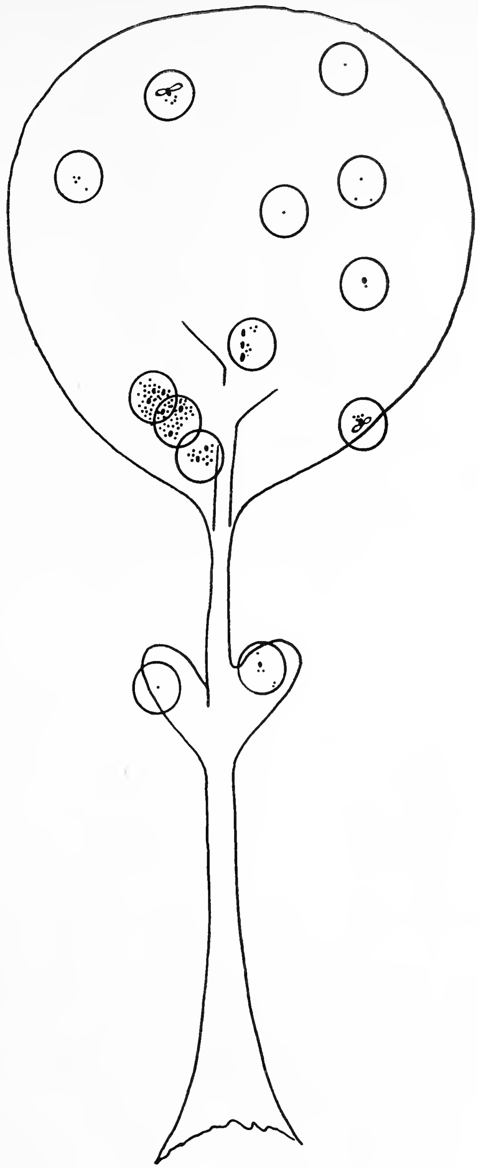

Fig. 3.—Diagram of mature leaf of Brussels sprouts with typical mid-season population of cabbage aphids. This leaf has 13 colonies.

aged by caterpillars. Where cabbage aphids covered large areas of the leaves, as in the checks, a circular area of covered leaf one half inch across, as estimated by inspection, was counted as one colony. A cabbage aphid in isolation, apterous or alate, settled on the leaf was also counted as one colony (figure 3).

At harvest 10 mature sprouts were taken, one from each of 10 plants per plot, every week for 7 weeks. These were weighed, inspected for caterpillar damage and examined by dissection for the presence of aphids. According to the absence or location of aphids they were categorized as clean, commercially acceptable, or rejected.

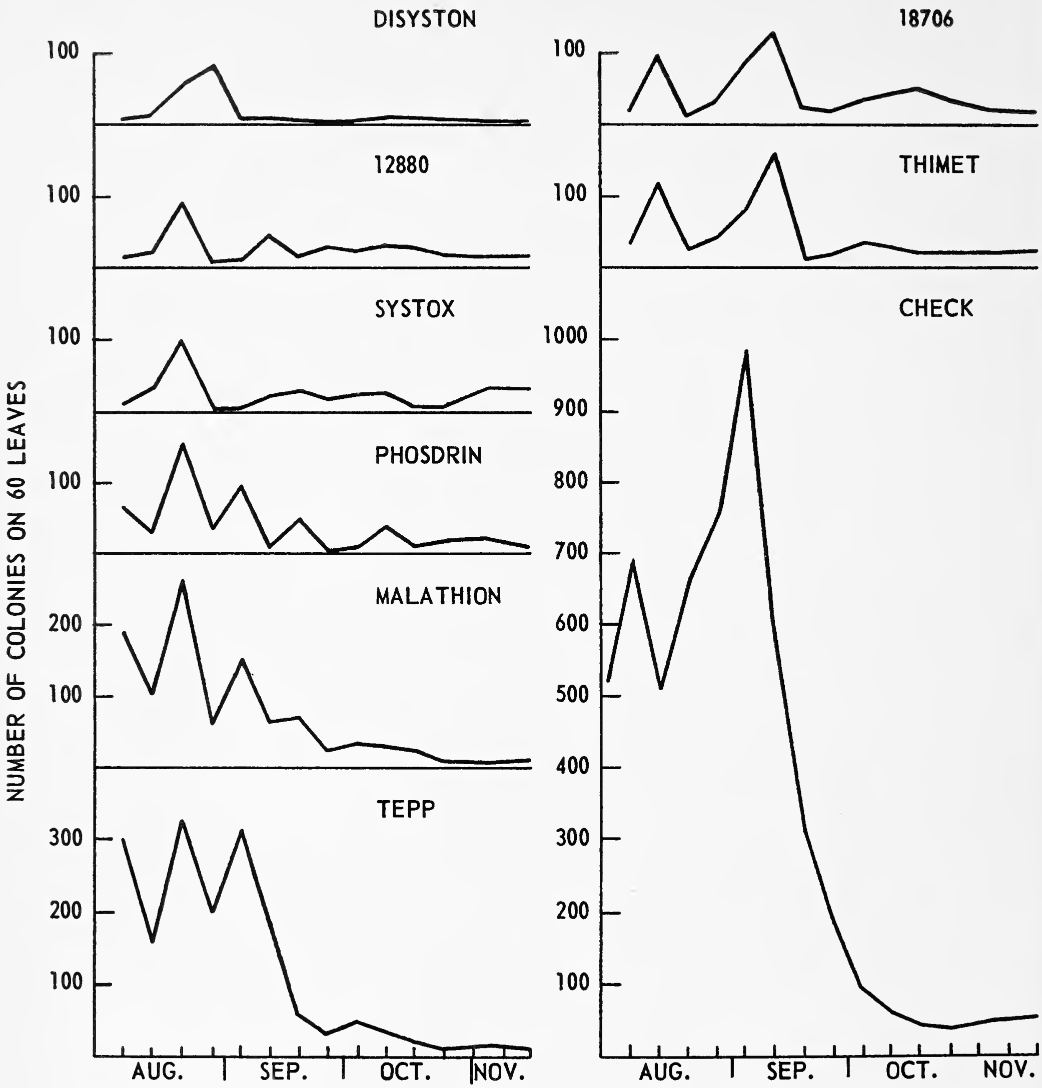


Fig. 4.—Populations of cabbage aphids on leaves of Brussels sprouts in all treatments at Vancouver, B.C., 1958.

Clean sprouts had no aphids in or on them; commercially acceptable sprouts had one or two aphids where they were easily washed off; rejected sprouts had aphids within the leaves where ordinary washing would not dislodge them. Differences between the treatments were assessed by analysis of variance.

Sprouts treated with Thimet, 12,880, 18,706, Di-syston, Systox, and Phosdrin were analyzed for residue by chemists of the British Columbia Research Council. Samples were taken from the field and immediately frozen on October 10 and 24. They were analyzed in February, 1959.

## Results and Discussion

Aphids were first noted on the plants on July 7; by July 29 there were high populations of both cabbage and green peach aphids. The population of cabbage aphids in the check plots built up steadily until September 5 after which it declined (figure 4). A fungus infection, braconid parasites, syrphid larvae, chryso-

**TABLE II—Aphid population totals from 14 weekly leaf counts[1], August 8 - November 14, 1958, on Brussels sprouts at Vancouver, B.C.**

| Treatment | **Brevicoryne brassicae** colonies | Percentage control | **Myzus persicae** adults | Percentage control |
|---|---|---|---|---|
| Di-syston | 215 | 96 | 497 | 11 |
| Systox | 358 | 93 | 304 | 46 |
| 12,880 | 352 | 93 | 182 | 67 |
| Thimet | 538 | 89 | 283 | 49 |
| Phosdrin | 563 | 89 | 357 | 36 |
| 18,706 | 531 | 89 | 165 | 70 |
| Malathion | 1074 | 78 | 810 | 0 |
| TEPP | 1722 | 65 | 763 | 0 |
| Check | 4958 | — | 558 | — |

[1] Each weekly count from an upper, a middle, and a lower leaf from each of 5 plants per plot, 20 plants per treatment.

pid larvae, and cool damp weather contributed to the decline. The population of green peach aphids rose until August 15 but fell rapidly thereafter.

Populations of cabbage aphids in all treatments during the season are shown graphically in figure 4. Data on the effectiveness of the treatments against aphids are summarized in Tables II and III. The systemics gave markedly better control than malathion or TEPP. Di-syston was the outstanding material against cabbage aphids but had little effect on green peach aphids, probably because the latter were confined to the old leaves. Systox and 12,880 were promising against cabbage aphids. Phosdrin reduced the population of cabbage aphids each time it was applied but it required 5 applications. 12,880 and 18,706 were the best materials against green peach aphids.

**TABLE III—Control of cabbage aphids and yield at harvest on Brussels sprouts at Vancouver, B.C., 1958.**

| | Clean Sprouts | | Marketable Sprouts | | Yield[2] |
|---|---|---|---|---|---|
| Treatment | Number[1] | Percentage | Number[1] | Percentage | gm. |
| Di-syston | 59.0 | 84 | 68.0 | 97 | 1256 |
| Systox | 49.2 | 70 | 63.5 | 91 | 1236 |
| 12,880 | 48.7 | 70 | 61.5 | 88 | 1213 |
| Thimet | 45.2 | 65 | 60.5 | 86 | 1173 |
| Phosdrin | 43.7 | 62 | 58.5 | 84 | 1212 |
| 18,706 | 36.2 | 52 | 58.2 | 83 | 1146 |
| Malathion | 28.0 | 40 | 52.5 | 75 | 1233 |
| TEPP | 27.7 | 40 | 49.2 | 70 | 1121 |
| Check | 20.7 | 30 | 51.2 | 73 | 882 |
| L.S.D. at | | | | | |
| 5% level | 7.9 | | 6.8 | | 138 |
| 1% level | 10.8 | | 9.2 | | 188 |

[1] Maximum of 70.
[2] Average weight of 70 sprouts.

**TABLE IV—Percentage control of caterpillars on Brussels sprouts at Vancouver, B.C., 1958.**

| Treatment | Percentage control based on: | | | |
|---|---|---|---|---|
| | Damaged sprouts[1] | Total caterpillars[2] | Leaves with more than 5% damage[2] | Undamaged leaves[2] |
| Phosdrin | 76 | 87 | 44 | 24 |
| Malathion | 64 | 81 | 27 | 16 |
| Thimet | 34 | 61 | 22 | 6 |
| 12,880 | 21 | 56 | 25 | 11 |
| TEPP | 21 | 31 | 31 | 13 |
| 18,706 | 6 | 12 | 0 | 0 |
| Systox | 3 | 36 | 0 | 0 |
| Di-syston | 0 | 4 | 0 | 0 |

[1] Sample of 280 sprouts: 40 taken each week from October 2-November 14.
[2] Sample of 840 leaves: 60 taken each week from August 8-November 14.

All treatments greatly increased the yield of sprouts and there were no significant differences between treatments in this respect. The increases in weight ranged from 27 per cent for TEPP to 42 per cent for Di-syston. Thus controlling cabbage aphids increased both the yield and marketability of sprouts.

Against caterpillars, Phosdrin and malathion were the best materials (Table IV). Di-syston, 18,706, and Systox gave virtually no control.

TEPP and malathion were applied 6 and 5 times respectively, or every 7 to 13 days during the season, but never reduced the populations to acceptably low levels (figure 4). Other insecticides were reapplied each time the weekly counts of cabbage aphid colonies showed more than 50 per 60 leaves. Thus Phosdrin required 5 applications, Thimet, Di-syston, and 18,706 required 3, and 12,880 and Systox required only 2, to maintain the population levels shown (figure 4).

Green peach aphids occurred almost exclusively on the old, lower leaves. Over the 14 weeks, 0.5 per cent occurred on upper leaves, 3 per cent on middle leaves and 96 per cent on lower leaves. This and the fact systemics may not be effectively translocated to leaves that are not growing rapidly may account for their relatively poor performance. TEPP and malathion gave no control of green peach aphids because the method of spraying and rate of application did not permit coverage of the lower leaves.

The cabbage aphid occurred at all levels on the plant as follows: 19 per cent occurred on upper leaves, 37 per cent on middle leaves, and 44 per cent on lower leaves.

The method of counting aphids gave valid data on their relative numbers and their location. Results were consistent among different counters. For cabbage aphids, colonies were counted, since this is a gregarious species and the colonies provided discrete units that were counted easily and rapidly. For green peach aphids adults were counted, since this is a solitary species and the aphids are found dispersed over the leaf. Fortunately green peach aphid populations remained low so that counting the adults was not unduly time consuming.

The portable barriers used during spraying worked well in practice, so that buffer rows were not needed. They eliminated spray drift and permitted spraying even on windy days. The barriers were light and easily moved into position (figure 2).

No residue was detected in any of the sprouts except in those treated with Phosdrin and harvested on October 10. In these the inhibition of cholinesterase was 8.3 per cent greater than in the untreated check. The intervals in days, between last treatment and the October 10 harvest were: Thimet, 25; 12,880, 46; 18,706, 25; Di-syston, 38; Systox, 46; Phosdrin. 18.

## PAINTED LADY, *Vanessa cardui*, on Vancouver Island

This cosmopolitan butterfly was common in Saanich, during 1958. Not since 1952 have I seen it in such numbers. As a matter of fact only a single specimen, in 1957, came to my notice between these dates. In 1958 I first noted it on May 18, and the last date recorded was October 1.

Soon after arriving in the district, from where I do not know, egg laying started on the two species of thistles abundant in the area, namely Canada thistle, *Cirsium canadensis,* and bull thistle, *C. lanceolata*. It seemed to prefer the latter. On June 18 I observed a female hovering about the head of a bull thistle where it was ovipositing so intently that it continued to lay even when I pulled the stem towards me for a closer look. In all, though not necessarily laid by this individual, 12 eggs were found, either on the involucre of the terminal flower head, or on the uppermost leaves just beneath the inflorescence. I snipped off the top of the plant containing the eggs and placed it under a muslin screen. The resulting caterpillars were reared to maturity. Adults emerged on July 17, one month after the eggs were laid.

During the course of the summer larvae in all stages of development were in evidence, varying from light yellowish green to almost completely black. Clumps of thistles soon assumed a bedraggled appearance, the bare leaf stalks festooned with the remnants of the silken cubicles in which the larvae lived or had lived. Pupae were rarely seen, however, as the caterpillars leave the food plant for less exposed quarters. Once in a while a chrysalis was found hanging within a very open-meshed tent along the leaf stalks of the host plant.

Fresh specimens of adults were common by July 18 and continued to be so well in September.

There is considerable overlapping of broods but with an average of one month for a complete life cycle and a constant succession of ova there could be two or more generations in one season, especially in a long, mild autumn as in 1958. From an economic point of view this is a useful insect, considering the ravages it commits among the thistles.

What becomes of the hosts of individuals seen up to October 1? They must do one of three things: Hibernate; but I have never come across them hereabouts, even early in the spring as in the case of the Mourning cloak and Angle Wing, both of which are known to hibernate. Emigrate; if so it is not noticeable. Or die before winter; here again I have no evidence in support of such a happening.

Most likely they are here in the first place as an overflow from Mexico or some other warm climate. They succeed well enough during the summer in their new haunt, but are unable to withstand the ensuing winter.

R. South in "The Butterflies of the British Isles" 1947 states that North Africa is thought to be the centre for this species, which periodically spreads all over the temperate world, where it thrives for a time but eventually disappears, until another wave of migrants from the original source re-populates its far flung range.

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# THE SATIN MOTH, STILPNOTIA SALICIS (L.), IN THE INTERIOR OF BRITISH COLUMBIA

J. C. ARRAND
A/Provincial Entomologist

The satin moth, *Stilpnotia salicis* (L.) was first reported in British Columbia at New Westminster in 1920. This pest was probably introduced from Europe about 1918. Condrashoff (1957) reported that by the summer of 1955 it had spread northeast to Kamloops and then south into Vernon. By 1958 it appeared to be well established east of Shuswap Lake and south at least as far as Penticton.

The Forest Biology Laboratory at Vernon recorded it in 1958 from the following Points in the interior: Celista, Adams River, Shuswap, Pritchard, Salmon Arm, Canoe, Sicamous, Falkland, Armstrong, Vernon, Woods Lake, Duck Lake, Kelowna, Okanagan Mission, Lower Trout Creek, and Penticton.

In the interior the larvae of the satin moth have caused light to severe defoilation of trembling aspen, *Populus tremuloides* Michy; White or Silver poplar, *Populus trichocarpa* Torrand Gray; Lombardy poplar, *Populus nigra* L. var *italica* Muench; Carolino poplar, *Populus Eugenei* Simon-Louis; and Willows, *Salix* spp.

Eggs of the satin moth are laid in masses on trunks, branches and leaves of the host or other trees or objects nearby. In 1958, in Vernon the moths began egg laying by about June 10. The larvae hatch in about two weeks and begin to skeletonize the leaves. After a few weeks they spin minute silken "huts" in bark crevices where they spend the winter. In Vernon, in 1958, these "huts" began to appear in late July. In the spring, shortly after the leaves have unfolded, the larvae resume feeding and may denude the trees by mid-June.

The best times to spray are about two weeks after the first larvae emerge from their winter quarters or at the peak of egg hatch. At these times the population consists mainly of early instar larvae which are most easily killed.

In 1958, poplar groves and some willow shade trees in and near Vernon, Kelowna, and Penticton were severely damaged by the satin moth. In some cases the trees were completely defoilated. These three cities were forced to apply control methods. A few resort and home owners in the Okanagan, notably at Mission Flats, south of Kelowna, and Woods Lake between Vernon and Kelowna, and at Okanagan Landing were also forced to spray their shade trees.

The city of Vernon hired a machine with a "Bean" pump, which was capable of applying 20 gallons of liquid per minute. A turbo mist fan attachment was used to narrow the spray stream and assure coverage of the 60 foot trees in Polson Park. DDT at 6 lbs. 50% wettable powder per 100 gallons of water applied on July 7 gave excellent control of the newly hatched larvae.

The cities of Penticton and Kelowna obtained similar results at the recommended dosage of 2-3 lbs. of 50% DDT wettable powder in 100 gallons of water.

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# SEVIN AS AN ORCHARD INSECTICIDE IN BRITISH COLUMBIA[1]

R. S. Downing[2]

The insecticide Sevin, unlike most of our present day insecticides, is an aryl urethane chemically termed N-methyl-l-naphthyl carbamate[3]. This compound has special interest where insects have become resistant to our commonly used insecticides such as DDT and malathion. Sevin has the very desirable characteristics of a comparatively low mammalian toxicity; the oral LD50 to rats of 500-700 mg/kg (1) is lower than that of DDT. Because of these factors, and since reports of preliminary experiments with Sevin for insect control from other institutions were favourable, experimental work with Sevin as an orchard insecticide was started at Summerland in 1957.

## GENERAL METHODS

Sevin was compared with either DDT or malathion depending upon the insect involved. Sevin and DDT were used as 50 per cent wettable powders and malathion as a 25 per cent wettable powder.

The method of application of the insecticide depended on the type and size of orchard available for experimentation. Where a large orchard with large trees was available, an automatic concentrate air-blast sprayer was used, whereas if the orchard was small, or if the trees were small, a high-volume, hand-gun sprayer was used. Except for one instance in which a Trump AS 36[4] concentrate sprayer was used, all concentrate spraying was done with a Turbo-Mist[5] concentrate sprayer. These sprayers applied about 50 gallons of spray liquid per acre. Unless otherwise stated, all hand-gun spraying was done with a two-gun, high-pressure sprayer, and the spray material was applied until it started to drip from the tree foliage.

## RESULTS AND DISCUSSION

### Control of the Codling Moth

In 1957, Sevin and DDT were applied with a concentrate sprayer to McIntosh and Golden Delicious in one orchard, and Delicious apples in another orchard to control severe infestations of the codling moth, *Carpocapsa pomonella* (L.). Three first brood sprays and one second brood spray were applied in each orchard. The numbers of apples injured by the codling moth were recorded at harvest.

In 1958, Sevin and DDT were applied with a concentrate sprayer to a Northern Spy apple orchard to control an infestation of the codling moth that had practically destroyed the previous year's crop. Starting one week after petal fall, three first brood applications, and two second brood applications, were made.

Sevin at six pounds per acre gave better control of the codling moth (Tables 1, 2) than did DDT at the same dosage.

Observations on the abundance of the apple aphid, *Aphis pomi* DeG., indicated that Sevin, as used against the codling moth, also controlled the aphid; but DDT allowed the aphid to develop heavy infestations. This was confirmed by Pielou (2) who studied the compound strictly as an aphicide.

Some mites, on the other hand, were not suppressed by applications of Sevin and in this respect Sevin was similar to DDT. Both years that Sevin was used for codling moth control, mites increased in the orchards. In 1958, the two-spotted spider mite, *Tetranychus bimaculatus* Harvey, de-

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[3] Union Carbide Chemicals Company, White Plains, New York.
[4] Trump Limited, Oliver, B.C.
[5] Okanagan Turbo Sprayers Limited, Penticton, B.C.

veloped to such high infestations that a special miticide, 18.5 per cent Kelthane wettable powder, 10 pounds per acre, had to be applied to all plots.

**Control of the Eye-Spotted Bud Moth**

The recommended method of controlling the eye-spotted bud moth, *Spilonota ocellana* (D. & S.) in the Okanagan Valley is to apply malathion in pre-bloom or summer sprays.

In 1957, Sevin was compared with DDT and malathion against the bud moth. The materials were applied at the pink bud stage with a stirrup pump sprayer to young Delicious apple trees. One week after treatment the bud moth nests on each of three, single-tree replicates were examined and the average percentage mortali-

**TABLE 1—Percentage Apples Injured by the Codling Moth at Harvest After Four Summer Applications of Sevin and DDT to Three Varieties of Apple Trees by Concentrate Sprayer. Naramata, B.C., 1957.**

| Insecticide, 50% w.p. | Pounds per acre[1] | No. of apples examined | Wormy apples, % |
|---|---|---|---|
| **Golden Delicious** | | | |
| Sevin | 6 | 3000 | 6.4 |
| DDT | 6 | 2535 | 12.5 |
| **McIntosh** | | | |
| Sevin | 6 | 1560 | 1.4 |
| DDT | 6 | 1536 | 8.4 |
| **Red Delicious** | | | |
| Sevin | 6 | 2060 | 2.0 |
| DDT | 6 | 2000 | 6.6 |

[1] Application made on May 23-24, June 3-6, June 17-20 and August 5-9.

**TABLE 2—Percentage Apples Injured by the Codling Moth at Harvest After Five Summer Applications of Sevin and DDT to Spy Apple Trees by Concentrate Sprayer. Summerland, B.C., 1958.**

| Insecticide, 50% w.p. | Pounds per acre[1] | No. of apples examined | Wormy apples, % |
|---|---|---|---|
| Sevin | 6 | 2518 | 0.0 |
| DDT | 6 | 2550 | 1.7 |

[1] Applications made on May 20, June 2, June 16-17, July 17, and August 7.

**TABLE 3—Average Numbers of Eye-Spotted Bud Moth Nests Found in a Ten Minute Search Per Tree After Sevin and Malathion were Applied to Jonathan Apple at Pink Bud Stage by Concentrate Sprayer. Summerland, B.C., 1958.**

| Insecticide | Pounds per acre | Numbers of bud moth nests: Rep. 1 | Rep. 2 | Ave. |
|---|---|---|---|---|
| Sevin, 50% w.p. | 8 | 6 | 11 | 8 |
| Malathion, 25% w.p. | 16 | 8 | 21 | 14 |
| Check—no treatment | — | 65 | 92 | 79 |

ties of bud moth larvae were:

| Insecticide | Pounds per 100 gallons | Mortality, % |
|---|---|---|
| Sevin, 50 per cent | 1.5 | 100 |
| Malathion, 25 per cent | 2.0 | 100 |
| DDT, 50 per cent | 1.5 | 1.7 |
| Check—no treatment | — | 0 |

In 1958, Sevin and malathion were applied at the pink bud stage to replicated, one-half acre plots of Jonathan apple trees with a Turbo-Mist sprayer. One month after spraying, each of six trees per plot was examined for ten minutes and the number of infested bud moth nests recorded (Table 3). This showed that Sevin was just as effective as malathion in controlling the overwintered eye-spotted bud moth at the pink bud stage of apple.

Furthermore, when it was compared with DDT in summer sprays to control the codling moth, as in the experiments already discussed, Sevin prevented injury from the newly hatched bud moth larvae in late July and August. In the DDT-sprayed fruit, on the other hand, bud moth injury was common.

## Control of the Fruit Tree Leaf Roller

Recommended control for the fruit tree leaf roller, *Archips argyrospila* (Wlk.) is by application of DDT at the pink bud stage of apple (3); at this stage about 15 per cent of the overwintered eggs of this species have hatched. However, reports from growers, and general observations by the writer in the past few years, indicate that DDT has proven only fairly successful.

Sevin, 1.5 pounds per 100 gallons, was compared with DDT, 1.5 pounds, for leaf roller control in 1957. A hand-gun sprayer was used to apply the insecticides at the pink bud stage to heavily infested Delicious apple trees. Three weeks after spraying, each of three trees per plot was examined for ten minutes, and the number of leaf roller nests found in that time was noted. The average numbers of nests per tree per plot were: Sevin, 1; DDT, 16; Check, 95.

In 1958, Sevin, 8 pounds per acre, and DDT, 12 pounds, were applied with a Turbo-Mist concentrate sprayer to very large Newtown apple trees in the early pink bud stage when the overwintered leaf roller eggs were starting to hatch. Records of leaf roller infestation were taken three weeks later and in the same manner as the previous experiment, but six trees per plot were examined instead of three. The average numbers of nests per tree per plot were: Sevin, 4; DDT, 17; Check, 108.

These experiments show that Sevin was more effective against the larvae of the fruit tree leaf roller than DDT when applied at the pink bud stage of apple.

When these materials were applied earlier, they were less effective. This was evident in 1958 when they were applied by hand-gun sprayer at the pink bud stage of apricot, i.e., approximately two weeks earlier than that stage on apple. One month after the application of Sevin, 1.5 pounds per 100 gallons, and DDT, 1.5 pounds, records of leaf roller infestation were taken by examining five trees per plot, and recording the numbers of leaf roller nests. By plots the average numbers of nests per tree were: Sevin, 53; DDT, 52; Check, 143. It is assumed, in this case, that after having weathered for two weeks or more, the deposits had deteriorated until they were incapable of killing the larvae as they hatched from the overwintered eggs.

## Control of the Peach Twig Borer

The usual method of controlling the peach twig borer, *Anarsia lineatella* Zell., has been to apply DDT at the pink or petal-fall stage of peach, or apricot (4), with the intent of killing the larva before it can cause injury to the twigs.

Sevin, 1.5 pounds per 100 gallons, was compared to DDT, 1.5 pounds, in 1958 when both materials were applied with a hand-gun sprayer to apricots that were in the pink bud stage. One month later, the numbers of flagged twigs were counted on each of five trees per plot. The average numbers of flagged twigs per tree in each plot were: Sevin, 0.0; DDT, 0.7; Check, 28.7.

## Control of Lecanium Scales

Soft scales, particularly *Lecanium* spp., have been particularly troublesome during the last few years, especially in 1957, in many peach and apricot orchards in the Okanagan Valley. Proverbs (5) experimented with scale insects that he designated as *Lecanium* sp. A and *Lecanium* sp. D. These have since been identified by Mr. J. H. H. Phillips, Vineland Station, Ontario as *Lecanium coryli* L. and *L. caryae Fitch,* respectively. Another species, *L. cerasifex* Fitch, has also become troublesome since Proverbs reported on his work. He stated (5) that malathion, as a summer spray, gave excellent control of nymphs of *Lecanium* sp. A, but a late pink bud spray was not so effective.

Because the fruit grower is usually very busy when summer spraying is most effective against *Lecanium* scales, pink bud, or pre-bloom sprays are considered preferable. With that in mind, Sevin was compared with malathion in concentrate application to peach or apricot trees at the pink bud stage. Large plots, one-half acre in size, were used to minimize reinfestation from one plot to another. In most cases, results were not recorded until the scale insect had matured, its eggs had hatched, and the young nymphs had moved from the twigs to the leaves. The results of these pink-bud spray experiments, conducted in 1957 and 1958 against *L. cerasifex,* are summarized in Table 4.

**TABLE 4—Average Numbers of the Scale** Lecanium cerasifex **Fitch per 50 Leaves in August After Application of Sevin and Malathion to Peach Trees, in 1957, and to Apricot Trees, in 1958, in the Pink Bud Stage by Concentrate Sprayer. Summerland, B.C.**

| Insecticide | Pounds per acre | Average numbers of scales per 50 leaves On peach trees 1957[1] | On apricot trees 1958[2] |
|---|---|---|---|
| Sevin, 50% w.p. | 8 | 64 | 77 |
| Malathion, 25% w.p. | 16 | 349 | 539 |
| Check—no treatment | — | 1580 | 958 |

[1] Average of two replicates.
[2] Average of four replicates.

In another apricot orchard, pink bud sprays of Sevin, 8 pounds per acre, and malathion, 16 pounds, applied with a concentrate sprayer, were compared for the control of *L. coryli*. One month after the applications, two twigs were sampled from each of five trees per treatment and the number of live and dead scales were counted. The percentage mortalities were: Sevin, 96.6%; malathion 94.4%; Check, 3.9%.

It is fairly evident from these experiments that Sevin was effective against the two species of *Lecanium,* being better than malathion against *L. cerasifex* and as good against *L. coryli.*

## Chemical Control of the Pear Psylla

The pear psylla, *Psylla pyricola* Foerst., was a serious pest in 1958. Infestations were numerous early in the season, and many fruit growers had difficulty controlling the pest with the recommended spray chemicals, especially malathion.

Sevin, 12 pounds per acre, was compared with malathion, 12 pounds, as a spray concentrate for pear psylla control during the summer of 1958. In one orchard, 10 days after treatment, the average numbers of live psyllids counted on samples of 20 leaves taken from each of five trees per plot were: Sevin, 1.0; malathion, 18.6; Check, 41.3. In two other orchards where Sevin was used, similar results were obtained indicating that it is a promising chemical for the control of the pear psylla.


### SUMMARY

Good control of eight species of insects was obtained from 50 per cent Sevin wettable powder [N-methyl-1-naphthyl carbamate] applied as follows:

1. Pink bud application on apple; 8 lb. per acre or, 1.5 lb. per 100 gal.
   Eye-spotted bud moth, *Spilonota ocellana* (D. & S.).
   Fruit tree leaf roller, *Archips argyrospila* (Wlk.).
2. Pink bud application on peach and apricot; 8 lb. per acre.
   *Lecanium coryli* L.
   *Lecanium cerasifex* Fitch.
3. Pink bud application on apricot; 1.5 lb. per 100 gal.
   Peach twig borer, *Anarsia lineatella* Zell.
4. Three or more summer applications on apple; 6 lb. per acre.
   Codling moth, *Carpocapsa pomonella* (L.).
   Apple aphid, *Aphis pomi* DeG.
5. Summer application on pear; 12 lb. per acre.
   Pear psylla, *Psylla pyricola* Foerst.



### ACKNOWLEDGEMENTS

Thanks are due to two members of the Entomology Laboratory, Summerland: Dr. James Marshall, who was responsible for the work done on the codling moth and the pear psylla, and G. D. Halvorson who assisted in the application of sprays. Two former members of the Entomology Laboratory, Summerland and now at the University of British Columbia, Vancouver, B.C., I. Lamont and K. Taylor assisted in the estimation of insect infestations.


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## Two Unusual Breeding Places of *Ptinus tectus* Boield. *Ocellus* Brown, the Brown Spider Beetle

A pest control operator consulted me about a house which he had twice fumigated with cyanide for so-called "wood borers" which were still coming out of the walls. I inspected the place and found spider beetles, on stairs on the upper floor, on the hall floor and issuing from the inner wall of the hall. Enquiry revealed that the owners had finished the top floor and the stairs with wall board about ⅝-inch thick that was apparently of corn stalk pulp bonded with casein, and had then papered over it. The emergence holes were distributed over the slabs of wallboard. Examination of the basement revealed a few beetles that had apparently emerged from the inner side of the wall board and had dropped or crawled down the inside of the wall. I came to the conclusion that beetles had oviposited on the boards in the factory, having been attracted by the casein bonding glue and that the grubs had fed and developed in the material and were now emerging as adults. The fumigation was not of sufficient strength to penetrate the wallpaper and kill the insects in their pupal cases inside the boards. Fumigation with methyl bromide corrected the trouble.

The second unusual breeding place occurred in a country cottage south of Langley. The owners wrote me about "wood-boring insects" issuing from papered walls around a plate glass window and from the hall. The walls showed emergence holes as plentiful as if the place had been hit by a blast from a shotgun. Opening the wall revealed laths covered with thick building paper, which had been stuck to the laths with a heavy coating of animal glue. Apparently spider beetles entered the wall and laid eggs on the glued paper; the grubs fed between the lath and the paper and formed pupal cells just below the wallpaper, through which they emerged leaving the shot-hole appearance, exactly like the emergence holes of Anobiid beetles.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# A BRIEF HISTORY OF THE POPLAR AND WILLOW BORER, *Sternochetus lapathi* (L.), IN BRITISH COLUMBIA[1]

By C. B. COTTRELL

The poplar and willow borer, *Sternochetus lapathi* (L.), introduced from Europe, was first observed in North America in 1882, when a single specimen was collected in New York (Herrick, 1935). During the next 20 years the weevil was observed in many localities in the northeastern United States (Matheson, 1917). In 1906, the first Canadian records were taken at three localities in Ontario (Cosens, 1912), and in 1908, Carolina poplars were attacked at Dundurn, Saskatchewan (Fletcher and Gibson, 1908). Between 1909 and 1916, occurrences were reported from many widely separated points in Ontario, and at Montreal, Quebec (Caesar, 1916).

The first known record of the poplar and willow borer in the Pacific Northwest was at Vernon, where in 1923, the late Col. A. E. Parlow collected a specimen. In 1924, poplar and willow trees in the Tourist Park at Kelowna were found to be infested, followed by reports of infestations at Penticton in 1932 and Summerland in 1934. The weevil's widespread distribution in the Okanagan Valley suggests that it was probably well established before these dates.

Other early records in the west were: Priest River, Idaho (P. C. Johnston, in litt.) and Tacoma, Washington, 1931 (M. H. Hatch, in litt.) and near Portland, Oregon in 1933 (Furniss, 1939).

A report of the borer's occurrence at Riske Creek in the Chilcotin area appears in the 1931 edition of the Canadian Insect Pest Review. For several reasons this record seems questionable: no specimen was taken; the host, trembling aspen (E. R. Buckell, in litt.), is unusual; and no weevil activity has been recorded in this area before or since.

On the Lower Mainland of British Columbia the first damage report came from a Vancouver garden in 1930, although it was stated in the Annual Report of the Forest Insect Laboratory at Vernon (W. G. Mathers, 1930), that the insect's presence had been known in this area for at least three years. In 1933 willows were attacked in Stanley Park, in 1934 at Green Timbers, and on Sumas Prairie in 1936.

Few infestations were recorded from 1936 to 1946, but in the period 1947 to 1949, with the expansion of the Forest Insect Survey staff, many new locality records were established: Chilliwack, Yale and Pitt Lake, 1947; Seymour Creek and Hope, 1948; Surrey, Allouette Lake, and Chehalis River, 1949. This indicates that the weevil was distributed throughout the Fraser Valley prior to 1947. On Vancouver Island, four records were obtained in 1948: Nanaimo, Coleman Creek, Port Alberni and Cowichan Lake.

Dr. M. Hatch of the University of Washington apparently has the first Kootenay record — a specimen collected at Creston in 1941; otherwise very little is known about the weevil's activities there before 1949. That year, numerous specimens were collected around the west arm of Kootenay Lake in the following localities: Queens Bay, Balfour, Kokanee, Nelson and Harrop. In 1951 several collections were made between Castlegar and Trail, and on the east side of Kootenay Lake at Crawford Bay. In 1952, damage was noted around the north end of Kootenay Lake and at Grand Forks in the Kettle Valley. In 1953, attacks were observed at Nakusp and Arrowhead, and at Kimberley and Bull River in the East Kootenay. Weevil attacks have continued in most of the above-mentioned infestations and in each successive year new locality records were obtained: Slocan

[1] Contribution No. 555, Forest Biology Division, Research Branch, Department of Agriculture, Ottawa, Canada.

[2] Forest Biology Laboratory, Vernon, B.C.

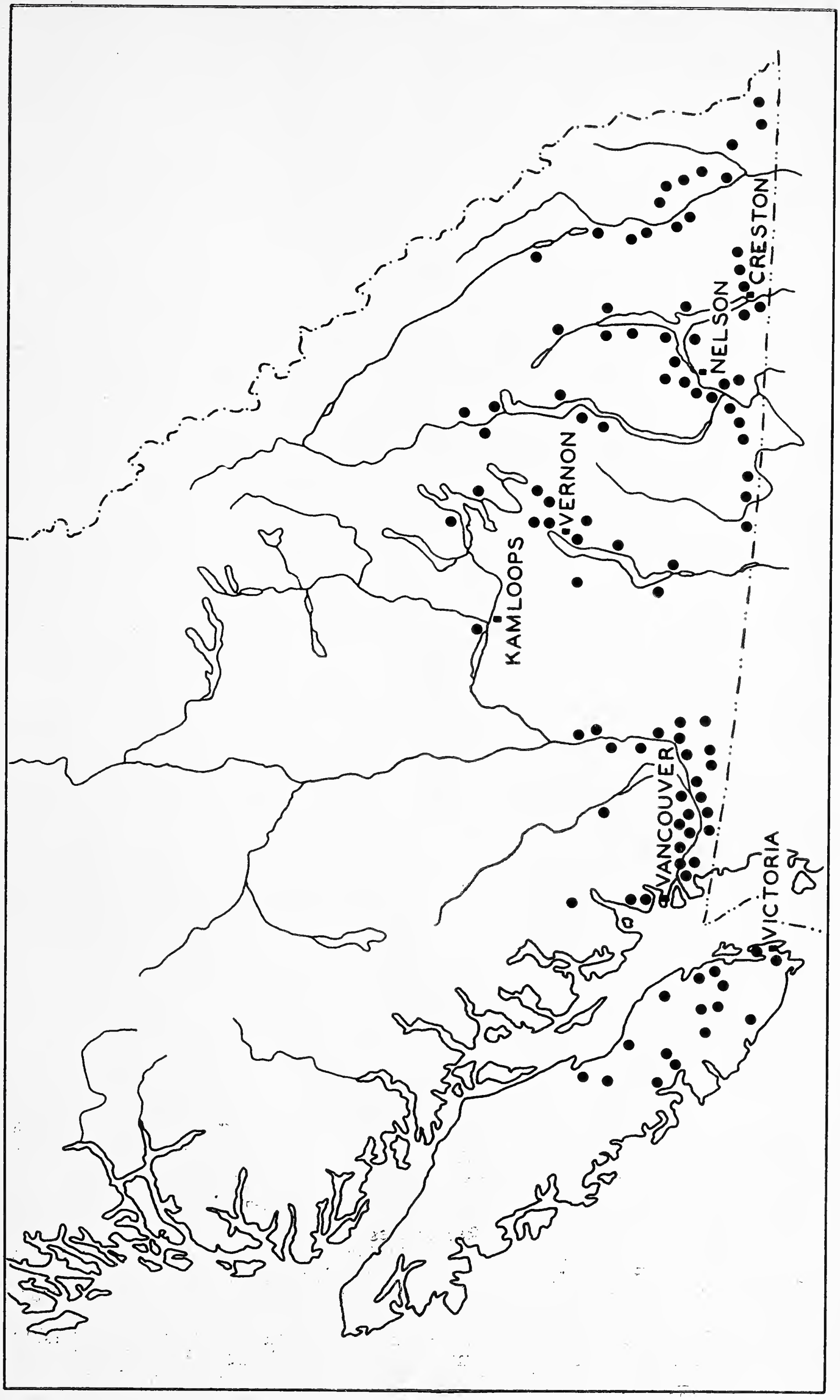


Fig 1.—Distribution of **Sternochetus lapathi** in British Columbia.

City and Natal, 1955; Revelstoke and Edgewood, 1956; Canal Flats, 1957; and Invermere, 1958.

At least four major infestations have occurred in British Columbia. At Sumas Prairie in 1936, approximately 12 years after Sumas Lake was drained, R. Glendenning reports, "this insect was so abundant on the several willow species that it effected some measure of control." By 1937, thousands of young willows had been killed. A stem sample, two and one half inches in diameter and two feet long contained 175 adults (H. G. Fulton, in litt.).

At Tranquille in 1958, an estimated 250 acres of mature willows, *Salix* sp., were killed.

On Creston Flats at the south end of Kootenay Lake, many willows, *Salix* spp., and black cottonwood, *Populus trichocarpa,* have been damaged.

All willows in a square mile area two miles northeast of Hope were heavily damaged and many trees were killed in 1958. Tree mortality also occurred at other points in the Fraser River Valley.

Although poplars and willows were attacked at Kelowna in 1924, native willow was the only known host in the Lower Mainland until 1939. In 1939, a black cottonwood was attacked at Vancouver, while ornamental willows were attacked in a nursery at Sumas. In the interior of British Columbia, Sitka alder, *Alnus sinuata,* has been infested at Celista, Sicamous and Brilliant, and mountain alder, *Alnus tenuifolia,* at Taghum. Occasionally weeping willow, *Salix babylonica* and Lombardy poplar, *Populus nigra,* have been infested but to date attacks on trembling aspen, *Populus tremuloides,* are rare.

Although the weevil is most numerous at low elevations in valleys or along waterways, where its favoured hosts are usually found, several collections have been made at high altitudes. In 1953, S. Hicks collected a specimen from willow in Garibaldi Park at the 3100 foot level (G. J. Spencer, in litt.). Near McCulloch, Sitka alders were attacked at 4100 feet elevation in 1958. In 1946, G. Stace-Smith collected a specimen from under a stone on the summit of a mountain near Creston, at an elevation of 7147 feet.

During the 36 years since the poplar and willow borer was first detected in British Columbia, this introduced species has become well established across the southern portion of the Province. (Fig. 1). Native willows and black cottonwood are its favoured hosts but it is also known to attack mountain and Sitka alders and several cultivated varieties of poplars and willows.

There is not sufficient evidence to draw any definite conclusion about the source of the original borer population in British Columbia. The borer's appearance in several localities in the Okanagan Valley in the 1920's, and in Vancouver in the 1930's, within a period of four years indicates that there may have been two separate introductions. The absence of Alberta and Montana records and the borer's early detection in British Columbia as compared with Idaho and Washington, may indicate that its entrance into this province was not the result of a natural spread from surrounding territory.

Unless otherwise stated, all data in this paper are from the files of the Forest Biology Laboratories at Vernon and Victoria.

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# NOTES ON THE LIFE HISTORIES OF FOUR MOTHS FROM SOUTHERN VANCOUVER ISLAND

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## Prosperpinus clarkiae Bdv.

This beautiful little sphinx has a wing expanse of 35 to 40 mm., the females usually the larger. The fore-wings are banded with varying shades of green, the most prominent a broad band across the centre. The hind wings are bright orange with a contrasting black border.

In my experience this species is not common. The years 1957 and 1958 were the first times I had seen it under natural conditions, after more than thirty years of searching. Individuals were seen in bright sunshine, flying low over beds of sea-blush, *Valerianella congesta.*

Two females of this species were taken in Saanich on April 29, 1958. They were confined over a flower-pot containing a sprig of *Galium aparine* which was thought to be one of its food plants as it was growing plentifully in the neighbourhood in which the adults were flying. By May 4 seven ova were obtained, one laid singly on a leaf, and six in a pile on the plant. The adults died after five days.

### Ovum

Size 1 by .90 mm., a slightly depressed sphere, smooth, shiny, pale translucent green. On May 11 the embryo could be seen through the shell, curled round the vertical axis of the ovum. Head pale greenish white, body green showing distinct segmentation. Hatched May 12.

### Larva—Ist Instar

Length 3 mm. Head dull, whitish. Body smooth, yellowish, faintly tinged with green, intersegmental rings pale yellow. It ate most of the egg shell. The larva would not touch the galium, but readily ate *Epilobium angustifolium.* Of the various herbs tried, this was the only one upon which it was successfully reared. Just prior to the first moult the larva was 5 mm. long, the body a dull glaucous-green, matching the mid-vein of the leaf along which it rested.

### 2nd Instar

May 21, length 6 mm. Head dull, pale flesh colour. Body slightly rough due to minute raised close-set white dots. Glaucous green, a slight indication of a tubercle on the dorsum of A. 8. May 24. Length 12 mm. with signs of approaching moult. A. 9 was a pinkish flesh colour matching the head, giving a two-headed effect. There was a faint pink suffusion along the spiracular line.

### 3rd Instar

May 26. Length 15 mm. Head light pastel purple. Body slightly rough as before, several transverse wrinkles on each segment. T. 1 and A. 9, purple, matching the head, a dull purple spot on dorsum of A. 8. Legs, dark brown, claspers purple with the same colour extending slightly on to the body. Underside green tinged with purple. When alarmed the larva reared the T. segments in the characteristic sphinx-like pose.

May 29. Length 20 mm. Head dull, smooth, sparsely short haired, pale purple. Body glaucous green, with white dots as before. T. 1 and part of T. 2 light purple. A. 9 pale purple, as were the legs, claspers and adjoining parts of the body. A light whitish line just above the spiracles. Spiracles white, ringed with black, about eight transverse wrinkles on each segment. Underside, light purple.

### 4th Instar

June 1. Length 20 mm. General colour and markings as before with the following additions: The purple on A. 9 had a tendency to increase and extend along the dorsum as far back as A. 6, or further. There was a faint dark dorsal and a clearly marked lemon yellow subdorsal line, with a distinct purple boss on the dorsum of A. 8. where the horn occurs in most

Sphingid larvae. The body tapered slightly towards the head.

**5th Instar**

June 9. Length 30 mm. Head purplish brown, covered with sparse, short hairs. Body with a wide dorsal band, black or dark fuscous having a tinge of purple. A. 1. to 5. with a pair of small, creamy dots. A. 8. with a round pink boss on dorsum, sides yellowish with ten thick, elongate, slightly oblique black bars, containing the spiracles in the centre of the row of bars. The whole body dotted minutely with black, and the underside a light purple colour. By June 13 the length was 45 mm. Head dull purplish-brown. Body fuscous above as before. A. 8. with a black-rimmed pink boss centred with an elliptical black spot. Sides yellow with a broad wavy black band running along and including the line of spiracles. Back and sides thickly dotted with black, the dots closely grouped at the juncture of the segments. Legs and claspers flesh colour. The underside purple. June 19. Length 55 mm. Full grown. By June 24 it had descended to the soil for pupation.

**Pupa**

Size 25 mm. by 7 mm. Smooth, dull, wing cases etched with a feathered pattern of fine lines. A. segments coarsely punctate on the anterior border, light brown, spiracles black. Cremaster a stout bifid spine terminating a narrow rugose protuberance on the last segment. Length of base and spine 2 mm. The pupa was widest at the middle of the A. segments, with the wing cases proportionally short and narrow.

## Lacinipolia petalis fletcheri Grt.

This is a rather common moth during June and July when it comes to light. The wing expanse averages 30 mm. and the general colour is light grey superimposed with darker lines and markings. A characteristic feature is the juncture of the orbicular and reniform spots at their lower edges, which readily separates this species from the very similar *L. pensilis* Grt. in which these spots are separate.

The following notes cover two years. Difficulties arose during the winter with the first group, so that the sequence is a blending of two groups, each supplying deficiencies in the other.

One batch of ova consisted of 95 eggs laid on or about June 24, 1955, placed indiscriminately on the sides and bottom of the container. The other was a similar number laid on July 7, 1957.

**Ovum**

Size, 1 mm. by .90 mm. Conical, finely ribbed, white; the apex and a ring slightly below, brown.

**Larva—1st Instar**

July 9. Length 2mm. Head light brown. Body pale translucent brown, with small tubercles bearing setae. The egg-shell was not eaten. After trying various plants the caterpillar accepted *Alnus rubra*.

**2nd Instar**

July 18. Length 4 mm. Head honey-coloured, short haired. Body olive-brown, smooth with scattered short setae. It ate small round holes in the epidermis on the underside of the leaf.

**3rd Instar**

July 28. Length 7 mm. Head as before. Body olive-brown, a thin white dorsal line with faint white suffused patches on each side of it on the centre of the A. segments. Tubercles black, each with a short seta. The larva kept out of sight by day under the dead leaves that lay at the bottom of the pile accumulated as fresh ones were added. It was very sluggish, hardly moving if touched.

**4th Instar**

August 7. Length 10 mm. Head as before. Body a drab fuscous brown, dorsum with grey lozenge-shaped saddles on the centre of each A. segment. Spiracular line broad, pale honey colour. Spiracles black. Underside pale fuscous. finely flecked with grey dots and etchings.

**5th Instar**

August 13. Length 17 mm. Much as before but darker, two white tubercles on the dorsum of A. 8.

**6th Instar**

August 29. Length 20 mm. Head pale brown, a dark V on front, sides freckled with fuscous. Body pale yellow-brown, heavily flecked with fuscous. Markings as before. By September 9 the body colour varied in individuals from dark fuscous to light grey-green, and the markings were not so evident. Some of the dark forms had two light ticks on the anterior margin of each segment. The lighter ones had a Y mark in the centre of A. segments. On October 19 they were very sluggish; evidently the winter diapause was imminent. The larvae were placed in a 10-inch flower-pot with moss and alder leaves. During the following winter they nibbled at slices of carrot.

February 9, 1958. Length 25 mm. The larvae came through the winter in good condition. No moult was observed after hibernation. Head shiny, smooth, dark brown mottled with lighter brown, sparsely short haired. Body fuscous-brown tinged with pink, having a thin broken white black-edged dorsal line with a suffused fuscous spot on the intersegmental region. T. segments darker. A dark spot on each side of A. 8. Spiracular broad, indistinct and broken, pale luteus. Underside similar to the upper but lighter in colour. The whole body covered with minute grey dots. Claspers flesh coloured with a dark spot on the outer side. A. 9. fuscous. The body tapered slightly towards the head. Just before pupation on March 29 the larva was 25 mm. in length. T. segments and A. O. darker than the rest. Dorsum showed two faint, dark dashes on the centre of the segments.

**Pupa**

Size 15 mm. by 4 mm. Smooth with a dull gloss, light reddish brown. Spiracles black. Cremaster consisting of about six stiff, straight hairs bunched together on a smooth knob at the end of the last segment.

**Imago**

Emerged May 17 to 21.

## Xylomiges cognata Sm.

This is a regular visitor to my porch light during March. The wing expanse is 35 mm. The forewings have a light grey background, on which are fine black lines and etchings, leaving a noticeably oblique lighter area across the centre. The hind wings are whitish with a conspicuous black dot in the centre and a thin black border on the hind margin.

A female taken at light in Saanich, on February 8, 1958, had laid 65 ova by February 13. The eggs were deposited on the side of the container in a single batch of one layer.

**Ovum**

Size 1 mm. by .50 mm. A flattened sphere, smooth, shiny with about 45 faint vertical ribs. Micropylar area depressed, reticulate. Pale cream colour, turning through light pink, pinkish-brown, to lead colour at hatching time. Hatched March 18, 1958

**Larva—1st Instar**

Length 2 mm. Head large in proportion, shiny, jet black. Body with a black cervical plate on T. 1. Rest of body a sordid bluish-white, short haired. They did not eat the eggshell. They were very restless, wandering ceaselessly with a pronounced tendency to climb upwards and showing no desire to eat for several days. Finally they nibbled at the buds of *Salix mackenziana* into which they burrowed out of sight.

**2nd Instar**

March 29. Length 6 mm. Head and cervical plate shiny, yet black. Body blue-black, semi-translucent. Dorsal and subdorsals thin, faint, milky-white; tubercles noticeably black. Legs black, claspers concolorous with the underside and upper part of the body.

**3rd Instar**

April 1. Length 12 mm. Head shiny, jet black. Body fuscous green, dorsal and subdorsals milky-white. Spiracular line consisting of two whitish lines enclosing pale green mottled with fuscous; spiracles black, underside light dusky green including the claspers, legs dark brown; black tubercles on the dorsum and sides very evident. As the *Salix* buds expanded the larvae tied the leaves together with silk, remaining out of sight within the leafy tent.

**4th Instar**

April 5. Length 15 mm. Head black with lighter mottling on sides. Body with a broad light fuscous green band including the white dorsal, bordered by the white subdorsals. Between the sub-dorsals and the spiracular line the ground colour is a darker shade of the dorsum. Spiracular line broad, white, flecked along the centre with pale green, which included the black spiracles.

April 9. Length 25 mm. They rested concealed in a folded leaf.

**5th Instar**

April 14. Length 30 mm. Head dark brown, with light mottlings on vertex and sides. Body with cervical plate shiny, dark brown mottled with lighter brown; rest of body grey-green between the white dorsal and sub-dorsals, darker below the latter, spiracular line a sordid grey, dorsum of A. segments with a dark U shaped line becoming more marked toward the last segment. Whole surface of body dotted with minute white spots.

April 20. Full grown. Length, 40 mm. Head pale flesh-brown, two oblique dark brown bars on front, vertex and sides faintly reticulated with dark brown. Body with shiny cervical plate concolorous with body, three white bars an extensions of dorsal and sub-dorsal lines which were white edged with fuscous; spiracular line less evident than before though broad and nearly concolorous with the sordid flesh of the underside, centred by a pale green suffusion, edged above with black, below with white. Spiracles black, legs pale brown, claspers the same colour as the underside. A. 4-9 with narrow fuscous U marks as before, the open end of the U directed forward. About April 30 the larvae spun light silken cells among the debris, where they lay quiescent until May 6 before the final change to the pupa was effected.

**Pupa**

Size 17 mm. by 5 mm. Smooth, shiny, wing cases minutely etched with wrinkles. A. segments finely punctate on the anterior margin, dark mahogany brown. Cremaster with 2 parallel hairs slightly recurved at the tips.

### Semiothisa teucaria Stkr.

This fairly common geometer has a wing expanse of 30 mm. Both fore and hind wings are light grey heavily dusted with fuscous. The forewings have three dark lines crossing them while the hindwings have but two.

It is closely associated with Garry oaks, and may be disturbed by day among the grass and herbage beneath the trees. It flies up quickly and alights as suddenly in the grass after a short flight, a manoeuvre that is repeated as often as it is disturbed. At Saanich 8 ova were obtained from a captive female on July 24, 1957. The eggs were laid singly on an oak leaf and on the sides of the container.

**Ovum**

Size .90 mm. by .50 mm. Oval, minutely reticulate, green turning dark at maturity. Hatched August 3, 1957.

**Larva—1st Instar**

Length 3 mm. Head shiny, pale brown. Body pale brownish green to nearly colourless, translucent, with 6 very fine lines on dorum and sides, more pronounced on T. segments, underside darker. Fed upon Garry oak, *Quercus garryana*.

**2nd Instar**

August 11. Length 5 mm. Head and body as before, less translucent.

**3rd Instar**

August 17. Length 7 mm. Head pale whitish green, dull, with a few short setae. Four vertical bars of light brown feathering. Body smooth, with a rather prominent spiracular fold, grey-green, with 6 more faint light lines on dorsum and a broader whitish spiracular line. Underside striped with alternate light and fuscous lines.

**4th Instar**

August 23. Length 16 mm. General colour and markings as before. Some individuals dark fuscous green with a broken whitish spiracular line, dark intersegmental rings and a pair of black spots on sides of A. 1 and A. 2.

**5th Instar**

August 31. Length 23 mm. Head milky green, mottled and feathered with light brown. Body grey-green with a tinge of cinnamon on ring joints, dorsum and sides with closely spaced pale brown lines, underside with black dots on segments. Some had a black mark on the centre of sides, in others the black was replaced with yellow. The cinnamon tinge varied among the larvae. The overall effect was to simulate the oak twigs, even to a thin short pubescence. They were full grown by September 4. Head pale biege with brown feathering as before. Body yellowish-brown with many fine lines and pale yellow dashes on sides of segments. September 12. All larvae pupated among the dead leaves at the bottom of jar.

**Pupa**

Size 11 mm. by 3 mm. Slender, smooth, slightly shiny, finely wrinkled on wing cases, punctate on A. segments, dark piceous brown. Cremaster a bifid spine with straight tips.

## On Mounting Lice by the Ris Lambers Method for Aphids

In the spring of 1958 Mr. Ron Forbes of the Federal Crop Insect Laboratory on the Campus showed me some microscope slides of aphids—the finest and clearest preparations of their kind that I had ever seen. He stated that they were made by the Hille Ris Lambers method and I immediately wondered if Mallophaga and Anoplura could be enslided by the same technique.

Through the efforts of Miss Eleanor Higham, student technician, I now have about 1000 slides of these 2 Orders made by this method. For practical purposes it is nearly as good as the standard KOH-Canada balsam method with the advantage that it is very much faster; one can have finished slides in about 45 minutes.

The method is as follows:

Place the insects in 90 per cent alcohol in a just-boiling water-bath until soft and soggy-looking i.e. in from 2-5 minutes. Then remove them and place in 10 per cent KOH in hot water-bath for from 1 to 5 minutes; experience tells how long. Transfer to Chloralphenol solution in the hot bath for 2 to 3 minutes to clear and mount in Hille Ris Lambers medium.

The formula for the mounting medium is:

| | |
|---|---|
| Gum arabic, clean white powdered | 12 grams |
| Concentrated pure glycerine | 6½ cc |
| Chloralhydrate | 20 grams |
| Distilled water | 40 cc |

Dissolve the gum arabic with the other reagents in the water and filter through glass wool two or three times until crystal clear. Place in a dust-free oven at 40° C in a flat dish and let the medium evaporate to half its original volume. Cool, and keep in dropping bottle.

The chloralphenol is made from equal parts by weight of chloralhydrate and crystals of pure phenol or carbolic acid, heated over a water-bath for 5 to 10 minutes.

This technique works better for Mallophaga than for Anoplura whose tough hide sometimes prevents penetration of chemicals and clearing. It is a curious thing that some sucking lice will clear and make perfectly transparent mounts and others from the same batch become only semi-transparent: the same trouble occurs with the KOH-balsam method, and is not the fault of the Hille Ris Lambers technique.

### Reference

D. Hille Ris Lambers. 1950. On mounting aphids and other soft-skinned insects. Entom. Berichten 13:55-58.

—*G. J. Spencer, University of British Columbia, Vancouver.*

# THE CONOPIDAE (DIPTERA) OF BRITISH COLUMBIA

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Through the kindness of Dr. G. G. E. Scudder I have recently been able to study a collection of Conopidae, taken in British Columbia by Professor G. J. Spencer, of the University of British Columbia. Since the collection (104 specimens) was a comparatively large one for this rather rare family it seems worth while to review all the species hitherto recorded from British Columbia. The classification followed is that of Parsons (1948) with additional synonomy from various papers by Camras and others. Keys for the determination of North American Conopidae will be found in the references. A list is given of collectors names and initials.

## CONOPINAE

### Physoconops obscuripennis (Williston)

*Conops obscuripennis* Will., 1882, Trans. Conn. Acad. Arts & Sci. 4:328-9.

*Conops brachyrhynchus* Macquart of Williston and others in error.

*Conops foxi* Van Duzee, 1927, Proc. Calif. Acad. Sci. 16:574.

Camras (1955:181) includes British Columbia in the range of this species. Western specimens have the posterior margin of the wing hyaline which led Van Duzee (1927) to describe them as a distinct species, *foxi*. New data: Kamloops, 13.vi.1943, G.J.S.

### Physocephala burgessi (Williston)

*Conops burgessi* Williston, 1882, Trans. Conn. Acad. Arts & Sci., 4:337.

*Physocephala brevirostris* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:579.

Camras (1957:213) includes B.C. in the range of this species, but gives no details. New data: Cobble Hill, 16.iv. 1912, Hooke Coll.; Goldstream 15.vii. 1923, K.F.A.; Newcastle Is., Nanaimo, 10.vi.1925, G.J.S.; Quesnel, 16.vii.1947, 20.vii.1947, 31.vii.1948, 14.vi.1949, G. J. S.; Salmon Arm, 20.vi.1929, H.B.L.; Salvus, 17.viii.1946, G.J.S.

### Physocephala texana (Williston)

*Conops texanus* Williston, 1882, Trans. Conn. Acad. Arts & Sci., 4:338.

*Conops affinis* Williston, Trans. Conn. Acad. Arts & Sci., 4:339.

*Conops ochreiceps* Bigot, 1887, Ann. Soc. Ent. France, 7:39.

*Physocephala humeralis* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:580.

*Physocephala humeralis simulans* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:581.

*Physocephala aurifacies* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:581.

*Physocephala buccalis* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:582.

*Physocephala rubida* Van Duzee, 1934, Ann. Ent. Soc. Amer., 27:315.

Camras (1957:213) includes B.C. in the range of this species, but gives no details. The high variability of *P. texana* has resulted in a number of synonyms. The species has been bred from nests of the Bembicid wasps *Bembix comata* Parker and *B. occidentalis beutenmuelleri* Fox (*vide* Bohart and MacSwain, 1939, Bull, So. Calif. Acad. Sci., 38: 84 and 1940, Pan Pacific Ent., 16:16). New data: Kamloops, 16.vii.1934, 25.vii.1937, 13.vi. 1943, G.J.S.; Penticton, 16.viii.1920, W.D.; Quesnel, 13.vii.1948, G.J.S.; Summerland, 26.vii.1920 (no captor given); Walhachin, 1.vi.1917, E.R.B.

### Physocephala marginata (Say)

*Conops marginata* Say, 1823, Jour. Acad. Nat. Sci. Philad., 3:82.

*Physocephala dakotensis* Van Duzee, 1934, Ann. Ent. Soc. Amer., 27:317.

*Physocephala stylifer* Van Duzee, 1934, Ann. Ent. Soc. Amer., 27:318.

Parsons (1948:232) records a specimen in the American Museum of Natural History from Nicola Valley, B.C.

## DALMANNIINAE

### Dalmannia picta Williston

*Dalmannia picta* Williston, 1883, Trans. Conn. Acad. Arts & Sci., 6:94.

This is the first member of this subfamily recorded from Canada. One male, Kamloops, 24.v.1935, G.J.S.

## MYOPINAE

### Myopa vesiculosa Say

*Myopa vesiculosa* Say, 1823, Journ. Acad. Nat. Sci., Philad., 3:80.

*Myopa apicalis* Walker, 1849, List of Dipt. Ins. in B.M., 3:679.

*Myopa bistria* Walker, 1849, *loc. cit.*: 679-80.

*Myopa conjuncta* Thomson, 1868, Eugenies Resa, Diptera: 515-6.

*Glossigona maculifrons* Bigot, 1887, Ann. Soc. Ent. France, 7:206-7.

*Myopa utahensis* Stains and Knowlton, 1940, Proc. Utah Acad. Sci. Arts Letters, 16:51.

Not previously recorded from B.C., but known from Quebec. New data: Chilcotin, 28.v.1929, G.J.S.; Salmon Arm, 4.v.1930, H.B.L.

## Myopa longipilis Banks

*Myopa longipilis* Banks, 1916, Ann. Ent. Soc. Amer., 9:197.

Previously only known from California, Idaho, Oregon, Utah and Washington. New data: Cobble Hill, 15.iv.1912, Hooke Coll.

## Myopa rubida (Bigot)

*Glossigona rubida* Bigot, 1887, Ann. Soc. Ent. France, 7:206.

*Myopa tectura* Adams, 1903, Kans. Univ. Sci., Bull., 2:35.

*Myopa clausa* var. *aperta* Roder, 1889, Wein. Ent. Zeit., 8:5.

*Myopa seminuda* Banks, 1916, Ann. Ent. Soc. Amer., 9:198.

Not previously recorded from Canada. Camras (1953:101) states that it is commonest in Washington, which adjoins B.C.; it appears to be fairly common in B.C. as the present collection contains nine specimens with data as follows: Salmon Arm, 3.v. 1920, 17.v.1932, 27.v.1932, H.B.L. (on shepherd's purse); Vancouver, 4.v. 1931, H.B.L.; Vernon, 1.v.1920, M.H.R.; Victoria, 28.vi.1919, 29.vi.1919, W.D.

## Myopa clausa Loew

*Myopa clausa* Loew, 1866, Centuriae VII, no. 72:101.

Camras (1943:101-2) gives the range of this species as 'Southern Canada and United States (Maine to Georgia, West to Washington and California.)'. He does not specify a Canadian province, neither does Parsons (1948:238). New data: Chilcotin, 13. vi.1921, E.R.B.; Kamloops, 12.vi.1946, G.J.S.; Quesnel, 24.v.1949, 28.v.1949, 30.v.1949, H.R.M.; 26.vi.1949, G.J.S.; Yale (pair *in copula*), 24.v.1948, G. J. S.; Cariboo Distr., Sorenson Lake, 25. v.1959, G.G.E.S.

## Myopa vicaria Walker

*Myopa vicaria* Walker, 1849, List of Dipt. Ins. in B.M., 3:679.

*Myopa pilosa* Williston, 1885, Trans. Conn. Acad. Arts & Sci., 6:383-4.

Not hitherto known from B.C., but recorded from Ontario and Quebec in Canada and the type in the British Museum is from Nova Scotia. I have also seen a specimen from Saskatoon, Sask., 23.iv.1943, P. Larkin. New data: Marpole, 1.iv.1950, coll. Farr. Peace River, 1949, D.G.H. Vancouver, 1.iv. 1949, G.B.R.; 1. iv.1950 (Univ. campus), H.J.; 2.iv.1950, coll. Richard. 20.iii.1950, E.F.; 9.iv.1950, H.A.M.; 4.iv. 1950, H.W.M.; 1.iv.1950, H.R.M.; 29. iii.?, M.O.

## Zodion fulvifrons Say

*Zodion fulvifrons* Say, 1823, Journ. Acad. Nat. Sci. Philad., 3:83.

*Zodion abdominalis* Say, 1823, *loc. cit.* 3:84.

*Myopa rubrifrons* Desvoidy, 1830, Mem. Sav. etr. Acad. Sci. Paris, 2:247.

*Zodion flavipenne* Bigot, 1887, Ann. Soc. Ent. France, (6) 7:204.

*Zodion lativentre* Graenicher, 1910, Canad. Ent., 42:26.

*Zodion sayi* Banks, 1916, Ann. Ent. Soc. Amer., 9:194.

*Zodion obscurum* Banks, 1916, Ann. Ent. Soc. Amer., 9:194.

? *Zodion bilineata* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:586.

Camras (1944:122) includes Southern Canada in the range of this species and Parsons (1948:240) mentions specimens seen from Nova Scotia and Ontario. Severin (1937, Ent. News, 48:243) has found this species as a parasite of worker honey bees in Dakota. New data: Chilcotin, 23.vi.1929, 20.vii.1930, G.J.S. Jesmond, 27.vi.1943, 20.vi.1943, G.J.S.

## Zodion intermedium Banks

*Zodion intermedium* Banks, 1916, Ann. Ent. Soc. Amer. 9:193.

*Zodion occidentale* Banks, *loc. cit:* 194.

*Zodion reclusum* Banks, *loc. cit:* 194.

*Zodion basalis* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:586.

Previously known from Quebec and Ontario in Canada, and U.S.A. New data: Quesnel. 10.vi.1947, 19.vi.1949, G.J.S.; 10.v.1948, H.R.M.

## Zodion ?perlongum Coquillet

*Zodion perlongum* Coquillet, 1902, Can. Ent., 34:199.

Males of this species are usually indistinguishable from *Z. fulvifrons,* but one male in the present collection has a very rufous abdomen and as Camras remarks in his key (1944:120) 'Some of the larger and more rufous individuals are probably males of *perlongum.'* A definite record for Canada if not for B.C. is a female in the Hope Dept., Oxford, from Ottawa, Ontario, 21.vii.1897, Mary Holmes. The data on the B.C. male which I can only place doubtfully as *Z. perlongum* are Kamloops, 18-22.vi.1954, G.J.S.

### Occemyia propinqua (Adams)

*Oncomyia propinqua* Adams, 1903, Kans. Univ. Sci. Bull., 2:32.

*Oncomyia augusticornis* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:595.

*Oncomyia longipalpis* Van Duzee, 1934, Ann. Ent. Soc. Amer., 27:321.

Camras (1945:218) gives Southern Canada and United States as the range of this species, but neither he nor Parsons (1948:244) give locality details. New data: Kamloops, 25.vii. 1937, 23.vii.1939, 22.vii.1945, 22.viii. 1958, G.J.S.; Quesnel, 19.vi. to 2.vii. 1949, G.J.S.; Royal Oak, 8.ix.1925, G. J. S.; Soda Creek, 27.vii.1949, G.J.S.

### Occemyia nigripes Camras

*Occemyia nigripes* Camras, 1945, Ann. Ent. Soc. Amer., 38:218-9.

Described from Ontario with paratypes from Quebec, Ontario, Manitoba, all parts of the United States and Guatemala. New data: Australian, 15.viii.1948, G.J.S.

### Occemyia loraria Loew

*Oncomyia loraria* Loew, 1866, Centuriae VII, No. 74, pp. 101-2.

*Oncomyia baroni* Williston, 1883, Trans. Conn. Acad. Arts & Sci., 6:97-8.

*Oncomyia brevirostris* Van Duzee, 1927, Proc. Calif. Acad. Sci., 16:593.

*Oncompia aequalis* Van Duzee, *loc. cit.*, 16:594.

*Oncomyia terminalis* Van Duzee, *loc. cit.*, 16:594.

*Zodion bimaculata* Curran, 1933, Amer. Mus. Novitates, 673:7.

*Oncomyia frontalis* Van Duzee, 1934, Ann. Ent. Soc. Amer., 27:322.

Previously recorded from Ontario and the range also includes the United States. New data: Quesnel, 31.vii. 1947, 10.vi.1948, 19 to 26.viii.1949, G. J. S.

### Occemyia modesta Williston

*Occemyia modesta* Williston, 1883, Trans. Conn. Acad. Arts & Sci., 6:96.

Camras (1945:220) gives the range of this species as southwestern Canada and western United States, east to Saskatchewan, Colorado and New Mexico. New data: Agassiz, 11.ix.1925, G.J.S.; Chilcotin, 23.vi.1929, G.J.S.; Midday creek, 11.viii.1920, N.I.C.; Royal Oak, 8.ix.1925, G.J.S.; Victoria, 8.ix.1925, G.J.S.

### Occemyia luteipes Camras

*Occemyia luteipes* Camras, 1945, Ann. Ent. Soc. Amer., 38:220-1.

Described from Washington with paratypes from California, Washington, Idaho, Utah and Colorado. New data: One female from Agassiz, 11.ix. 1925, G.J.S.

There are four male Occemyia which I am unable to determine to species. Intermediates in size and coloration occur in the genus and without the females such examples are impossible to determine with certainty.

### LIST OF COLLECTORS

E.F.—E. Fridell
E.R.B.—E. R. Buckell
G.B.R.—G. B. Rich
G.G.E.S.—G. G. E. Scudder
G.J.S.—G. J. Spencer
H.A.M.—H. A. Magel
H.B.L.—H. B. Leech
H.J.—H. Johnson
H.R.M.—H. R. MacCarthy
K.F.A.—K. F. Auden
M.H.R.—M. H. Ruhmann
M.O.—M. Oswell
N.I.C.—N. I. Cutler
W.D.—W. Downes
D.G.H.—not known

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Camras, S., 1944, Notes on the North American species of the **Zodion fulvifrons** group (Diptera, Conopidae), Pan Pacific Ent., 20 (4): 121-128.

Camras, S., 1945, A study of the genus **Occemyia** in North America (Diptera, Conopidae), Ann. Ent. Soc. America, 38: 216-222.

Camras, S., 1953, A review of the genus **Myopa** in North America (Diptera, Conopidae), Wasm. Journ. Biol., 11: 97-114.

Camras, S., 1955, A review of the new world flies of the genus **Conops** and allies (Diptera, Conopidae), Proc. U.S. Nat. Mus., 105: 155-187.

Camras, S., 1957, A review of the new world **Physocephala** (Diptera, Conopidae), Ann. Ent. Soc. America, 50: 213-218.

# PERSISTENCE OF SEVIN AND DIAZINON RESIDUES ON FRUITS[1]

K. WILLIAMS[2]

Since Section B 15.002 of the Regulations under the Food and Drugs Act established official Canadian tolerances for pesticide residues (Morrell, 1957), the determination of such residues on fruits has become more important than heretofore. Diazinon [*O,O*-diethyl *O*-(2-isopropyl-4-methyl-6 - pyrimidinyl) phosphorothiate; Geigy Agricultural Chemicals New York, N.Y.] and Sevin (1-naphthyl N-methylcarbamate; Union Carbide Chemicals Company, White Plains, New York) are recommended for the control of several tree fruit pests in the Okanagan Valley of British Columbia (Anon., 1959). It is generally acknowledged that the type of formulation, or the addition of surfacants may markedly affect both the initial deposit of pesticides, and the persistence of the residue (Gunther and Blinn, 1955). This paper deals with the residues found on apples and cherries that had been sprayed with commercial formulations of Diazinon or Sevin.

[1] Contribution No. 14 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Chemist.

## Methods and Materials

Duplicate single tree plots of young cherry trees were sprayed with a 25 per cent wettable powder formulation, or with a 25 per cent emulsifiable concentrate formulation, of Diazinon. Spray - concentration was one - half pound of actual Diazinon per 100 gallons of water; 30 gallons of spray liquid were applied to each tree with a hand spray gun.

In another experiment Diazinon was applied to two large plots of mature apple trees, and Sevin to five large plots. A standard air-blast concentrate sprayer moving at one mile per hour and applying 50 gallons of liquid per acre at a pressure of 300 pounds per square inch was used in this work. Details regarding spray formulations and application dates for this experiment are given in Table 1.

For assay of Diazinon residues, 50 cherries and 50 leaves were picked at random immediately after treatment, and one, four, eight and 14 days later. The samples of unwashed whole fruit were processed with n-hexane. A disc, one centimetre radius, was cut from

TABLE 1—Residues (Means of Five Determinations) of Sevin and Diazinon on Fruit of Three Varieties of Apple Trees after Several Applications of a Concentrate Spray.

| Spray Dates | Materials | Amount per Acre per Spray | Residues Days after Last Spray, p.p.m.* 0 | 7 | 14 | Harvest** |
|---|---|---|---|---|---|---|
| **Golden Delicious** | | | | | | |
| May 23, June 6, 18 | | | | | | |
| August 3 | Sevin 50% w.p. | 6 lb. | 6.1 | 4.2 | 2.7 | 1.4 |
| **Red Delicious** | | | | | | |
| May 24, June 6, 20 | | | | | | |
| August 9 | Sevin 50% w.p. | 6 lb. | 6.2 | 3.4 | 2.8 | 0.7 |
| **Northern Spy** | | | | | | |
| May 24, June 6, 17 | Sevin 50% w.p. | 6 lb. | 4.8 | 2.9 | 2.6 | — |
| July 17, August 7 | Sevin 50% w.p. | 3 lb. | 2.3 | 1.5 | 0.8 | — |
| | Sevin 50% w.p. | 6 lb. | | | | |
| | Triton B-1956*** | 1 pt. | 4.2 | 3.2 | 2.0 | — |
| | Diazinon 25% w.p. | 8 lb. | 2.6 | — | 0.3 | — |
| | Diazinon 25% w.p. | 8 lb. | | | | |
| | Triton B-1956 | 1 pt. | 2.8 | — | 0.4 | — |

* Official Canadian tolerance: Diazinon, 0.75 p.p.m.; Sevin, 10 p.p.m.
** Golden Delicious, 29 days; Red Delicious, 41 days.
*** Rohm and Haas Co., Philadelphia, Pennsylvania.

each leaf in the 50-leaf sample and the 50 discs were processed as a single unit with n-hexane.

Apple samples for assay of Sevin residues were collected from all plots immediately after the final spray and seven and 14 days later. At harvest samples were taken from two plots. For the determination of Diazinon residues fruits were sampled immediately after the final spray and 14 days later. Samples of ten apples were picked at random from each of five selected trees in each plot; these were processed with chloroform to remove Sevin residues, or with n-hexane to remove Diazinon residues.

Aliquots of the stripping solutions were analyzed for Diazinon by a colorimetric method based on the hydrolysis of Diazinon to inorganic phosphate (Geigy Agricultural Chemicals, 1956) and for Sevin by a colorimetric method based on hydrolysis of Sevin to 1-naphthol (Miskus, R., University of California, Berkeley, unpublished results).

## Results and Discussion

Immediately after spraying with six pounds of 50 per cent wettable powder per acre the residues of Sevin on apples (Table 1) were well below the tolerance of 10 parts per million. The maximum dosage recommended in the British Columbia spray calendar is 12 pounds of Sevin, 50 per cent wettable powder per acre, and the data indicate that, at this dosage, the last spray can be applied up to one week before harvest without exceeding the residue tolerance.

At the eight pound per acre dosage of Diazinon, 25 per cent wettable powder, the residue on apples was well below the tolerance of 0.75 part per million 14 days after the final spray (Table 1). The recommended dosage is 12 pounds per acre, and the data indicate that, at this dosage, the last spray can be applied up to two weeks before harvest.

The addition of a spreader-sticker, Triton B-1956, apparently had no effect on the initial deposit nor on the persistence of Sevin and Diazinon residues on apples.

TABLE 2—Residues (Means of Two Replicates) of Two Formulations of Diazinon on Fruit of Cherry Trees after One Application of a Dilute Spray.

| Material | Amount per 100 Gal. | Residues, Days after Spraying, p.p.m.* 0 | 1 | 4 | 8 | 14** |
|---|---|---|---|---|---|---|
| Diazinon, 25% emulsifiable concentrate | 2 lb. | 5.8 | 4.6 | 2.4 | 0.7 | 0.3 |
| Diazinon, 25% wettable powder | 2 lb. | 8.6 | 4.7 | 2.1 | 0.6 | 0.2 |

* Official Canadian tolerance, 0.75 p.p.m.
** Harvest.

Sevin is more persistent on apples than Diazinon. About 50 per cent of the initial deposit of Sevin remained on the fruit two weeks after the final spray in comparison with only about 15 per cent of the Diazinon. Since there is about a 50 per cent loss of Sevin in two weeks, a fairly reliable estimate of the residue at harvest can be made from a residue analysis before harvest.

The data from Diazinon residues on cherries (Table 2) indicate that the persistence is similar for the wettable powder and emulsifiable concentrate formulations, and that the residue is below tolerance eight days after spraying.

The analytical results for Diazinon on cherry fruit and foliage, and on apple foliage, immediately after spraying (Table 3) indicate that the residues on cherry foliage were much lower than on cherry fruit, or on apple foliage, when the spray was applied by a high-volume hand gun. Evidently there was greater "run-off" of spray liquid from the cherry foliage. It may be that, in low-volume concentrate spraying where there is no run-off, the initial residues on cherry and apple foliage would be similar.

TABLE 3—Average Residues of Two Formulations of Diazinon on Fruit and Foliage of Cherry Trees and on Foliage of Apple Trees Immediately after One Application of a Dilute Spray.

| Materials | Amount per 100 Gal. | Residues, mmg. per sq. cm. | | |
|---|---|---|---|---|
| | | Cherry* | | Apple** |
| | | Fruit | Foliage | Foliage |
| Diazinon, 25% emulsifiable concentrate | 2 lb. | 2.0 | 0.4 | — |
| Diazinon, 25% wettable powder | 2 lb. | 3.5 | 0.7 | 2.9 |

* Means of two replicates.
** Mean of eight replicates.

## Summary

Data are given showing the amount of Diazinon residues on cherries and apples, and Sevin residues on apples. Results indicate that Diazinon residues on cherries were similar for a wettable powder formation and an emulsifiable concentrate formulation. The addition of a surfactant to Diazinon and Sevin sprays on apples did not affect the magnitude of the initial residues nor the persistence of the spray residues. Sevin residues on apples were more persistent than Diazinon residues.

The author is indebted to F. E. Brinton for assistance in sampling and chemical analyses.

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# RESISTANCE TO DDT IN THE CODLING MOTH IN BRITISH COLUMBIA[1]

J. Marshall[2]

In 1934 Hough (5) determined that there was considerable variation in the ability of larvae of the codling moth, *Carpocapsa pomonella* L., from Colorado and from Virginia, to penetrate deposits of lead arsenate, and of several other codling moth insecticides. He attributed the variation to difference in vigour. Whatever the reason, from that time until the beginning of the DDT era in orchard pest control in 1946, evidence mounted that lead arsenate was gradually losing its effectiveness in many areas where the insect was a serious pest.

Particularly in arid, or semi-arid, areas such as the Okanagan Valley of British Columbia, DDT was a spectacular success; even indifferent application of the new insecticide proved adequate (6). Orchardists brought to the brink of ruin by the codling moth became successful again, and serious loss of fruit from codling moth injury became a thing of the past. But five or six years later there were hints of trouble. Extra applications of DDT were becoming common although weather conditions were not very favourable for the development of the insect. Spraying technique, however, had radically changed between 1949 and 1952 (7).

[1] Contribution No. 5 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.
[2] Entomologist.

Air-blast spraying had replaced hand-gun spraying, and some of the new machines were woefully inadequate. We hoped that the trouble lay in the spray equipment, or in its operation.

Then came a disturbing experience. While visiting the deciduous fruit districts of Australia in 1954 I was shown an orchard in the Paracombe district of South Australia that was very heavily infested by the codling moth, although it had received ten thorough applications of DDT. Satisfied that the insecticide was up to strength, the Chief Horticulturist for South Australia, Mr. A. G. Strickland, was of the opinion that the codling moth in that orchard had become resistant to DDT. His opinion was experimentally confirmed by Smith (8).

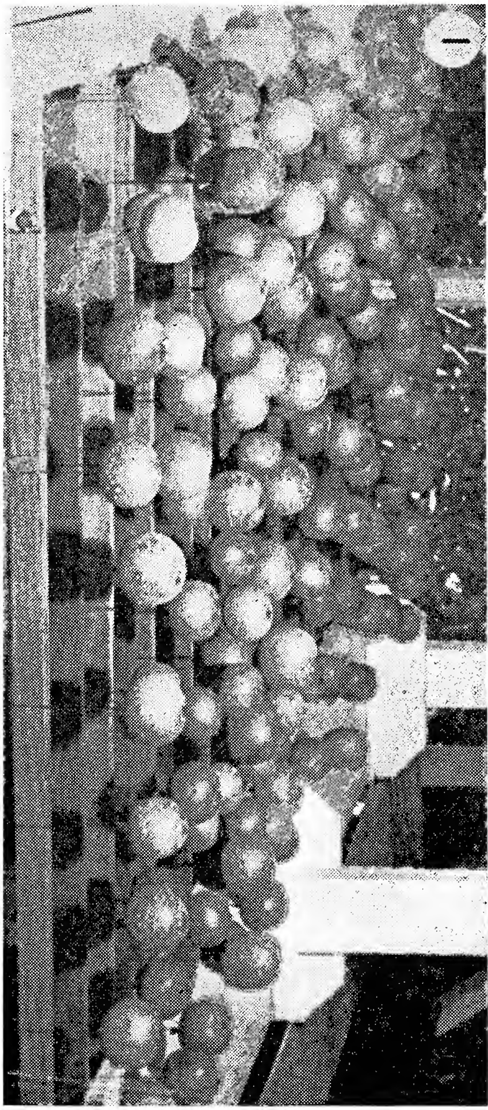
Shortly afterwards Cutright (2) showed that the codling moth had become resistant to DDT in an orchard in Ohio. A year later Glass and Fiori (3) demonstrated that the same thing had happened in an orchard in New York State; and the following year Hamilton (4) reported that DDT-resistant codling moth was present in two orchards in the State of Washington. The latest published evidence of what is evidently an accelerating tendency comes from California where Barnes (1) has demonstrated the existence of a strain of the codling moth that is about four times as hard to kill with DDT as a strain that had not previously been exposed to DDT (L. D. 50 four times as great).

In British Columbia we continued to hope that reports of increasing codling moth infestations could be ascribed to faulty spraying, as indeed most of them appeared to be. But in June 1958 came word of a situation in an orchard near Kelowna that was evidently in a different category. Despite the application of four first-brood sprays of 50 per cent DDT wettable powder at the recommended dosage of 12 pounds per acre, about half of the crop was infested by codling moth larvae of the first brood by mid-June. This, in fact, was a considerably heavier infestation than in the non-sprayed trees in the Entomology Laboratory orchard at the same date. Without delay we commenced a laboratory experiment to determine if, finally, we had to deal with DDT-resistance.

Moths were reared simultaneously from infested apples taken from the Kelowna orchard (designated as Glenmore stock), and from apples taken from either the Entomology Laboratory orchard, or from a relatively isolated abandoned orchard (designated as laboratory stock). The laboratory orchard, from which about 80 per cent of the laboratory stock was taken, had never been sprayed with DDT, nor any other chlorinated hydrocarbon. Although, to the best of our knowledge, the abandoned orchard had received no DDT, it is possible that, for several years after the introduction of DDT (in 1946), it had received DDT in limited amount.

Female moths from both stocks were allowed to lay eggs on waxed paper. Small pieces of paper hearing a total of 5 or 10 eggs, about to hatch, were pinned to non-sprayed apples, and to apples that had been sprayed to the beginning of drip with a water-suspension of 50 per cent DDT wettable powder and then allowed to dry. Spraying was done with a small De Vilbiss atomizer under constant air pressure of 15 pounds per square inch. Before the apples were sprayed the calyx basins and the stem basins of the fruits were filled with melted paraffin wax to restrict entries to a uniformly-sprayed surface. The apples were suspended by threads from racks in the insectary (Fig 1), and examined for codling moth entries two weeks after the eggs had been pinned to them. In all, 3000 eggs were used in the experiment.

The apples, variety Spartan, were sprayed with three concentrations of 50 per cent DDT wettable powder (Fig. 2): 0.5 gram, 1.5 grams and 4.5 grams per liter — amounts roughly equivalent to 4 pounds, 12 pounds and 36 pounds per acre. Chemical analyses of the apples showed the following



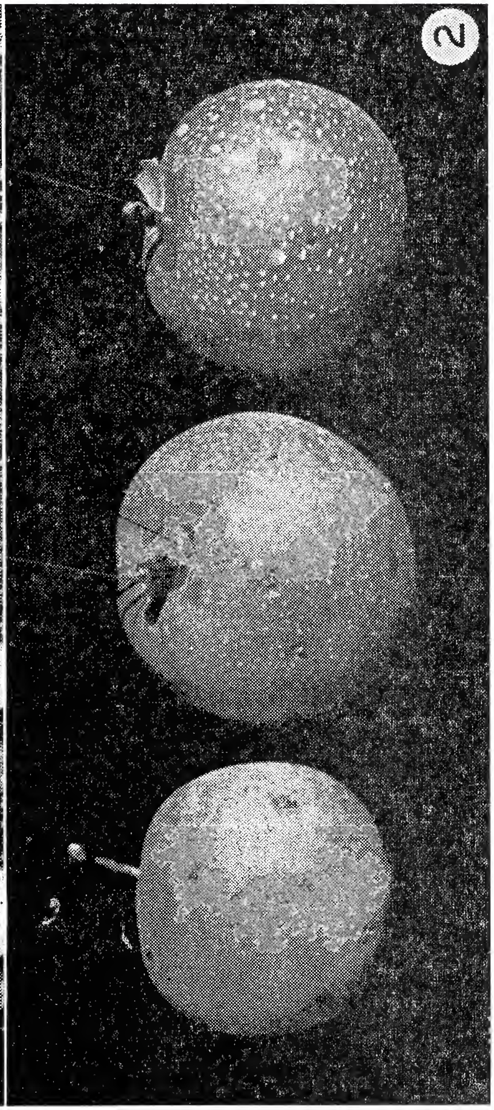


Fig. 1.—Apples suspended by threads in insectary for codling moth entry.

Fig. 2.—Apples sprayed with three concentrations of DDT showing deposits and codling moth entries.

average DDT deposits as parts per million: 1.07, 3.61, and 7.61 respectively. Analysis of the commercial 50 per cent DDT wettable powder that was used in the experiment showed it to be as guaranteed: Actual DDT 50 per cent, para para isomer content of the DDT 80 per cent.

The eggs of the two stocks of insects hatched in approximately the same numbers, 75.2 per cent to 98.7 per cent according to date of deposition. The larvae of the laboratory stock were just as capable of penetrating non-sprayed apples as those of the Glenmore stock (Table 1); presumably, therefore, they were just as vigorous. This is contrary to Hough's conclusions of twenty-five years ago with Colorado larvae resistant to a number of insecticides, and with non-resistant Virginia larvae; he found the non-

TABLE 1. Entries by resistant (Glenmore stock) and non-resistant (laboratory stock) codling moth larvae in non-sprayed and in DDT-sprayed apples.

| DDT 50% w.p. gm./1. | Equivalent pounds per acre | DDT deposit p.p.m. | Stock | No. eggs | Entries % Non-sprayed apples | Entries % DDT-sprayed apples |
|---|---|---|---|---|---|---|
| 0.5 | 4 | 1.07 | Glenmore | 300 | 91.4 | 89.6 |
| | | | Laboratory | 300 | 85.8 | 10.0 |
| 1.5 | 12 | 3.61 | Glenmore | 600 | 86.0 | 65.1 |
| | | | Laboratory | 600 | 86.1 | 4.4 |
| 4.5 | 36 | 7.61 | Glenmore | 600 | 90.4 | 49.4 |
| | | | Laboratory | 600 | 90.9 | 0.8 |

resistant larvae less vigorous. On the other hand, the laboratory stock larvae were far less capable of penetrating a DDT deposit than the Glenmore ones. The capacity of the Glenmore larvae to enter fruit sprayed with DDT at a dosage roughly equivalent to 36 pounds of 50 per cent wettable powder per acre was the more striking because the spray deposit was more uniform than in the orchard, and so, presumably more effective. Actually, at that dosage, three times as great as the official recommendation, over fifty times as many of the Glenmore larvae made successful entries as did the laboratory larvae.

Although the codling moth appears to be more difficult to control in the Glenmore orchard than in any other orchard in British Columbia, several growers in the Osoyoos, Oliver, and Keremeos areas have lately been having great trouble in keeping the insect at a low level, despite as many as six applications of DDT at recommended dosage. Hundreds of other growers are having to apply from one to three more codling moth sprays than they found necessary for some five years after DDT came into general use. In view of the clear experimental evidence of the development of resistance to DDT in the Glenmore orchard, and the strong circumstantial evidence of grower experience, it is evident that, to a varying degree, the effectiveness of DDT against the codling moth is declining.

We are concerned with both the genetical aspects of this problem and the role of the orchardist in it. Is the grower's role a passive one, or might his spraying affect the rate of development of resistance to insecticides? Will a low concentration of an insecticide select resistant strains of an insect more rapidly than a high concentration? Are trees, oversprayed on the bottoms and undersprayed on the tops, more likely to accelerate the selection of insecticide - resistant strains of insects than trees unformly covered with spray mixture? Is it desirable to use one insecticide for several years, then, before insecticide-resistance becomes evident, change to another for several years? Is a mixture of insecticides of significantly different chemical composition preferable to a single insecticide? Are highly toxic insecticides likely to select resistant strains of insects more rapidly than less potent ones? These have become significant questions for the fruit grower, and doubtless they will become even more so while chemical control remains our main line of defence against orchard pests. In an attempt to provide answers a new project is underway in which the Entomology Laboratories at Vineland Station, Ontario, and at Summerland, British Columbia, are collaborating.

## Summary


1. The presence of a strain of the codling moth resistant to DDT has been experimentally demonstrated in British Columbia.
2. Over 50 times as many larvae from the resistant strain penetrated a heavy deposit of DDT as did larvae from a strain that had not been annually subjected to DDT sprays.

3. The fertility of the eggs of the two strains did not differ; nor did the capacity of the two stains of larvae to penetrate non-sprayed fruits.
4. DDT-resistance is evidently fairly widespread in the orchards of the South Okanagan area, but the degree of resistance is variable.

**Acknowledgments**

Much of the work in this experiment was done by these members of the staff of the Summerland Entomology Laboratory: Dr. M. D. Proverbs, Messrs. K. Williams, J. Newton and J. Ogilvie, and by Mrs. Bernice McDonald.

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## OUTBREAKS OF GRANARY WEEVILS IN HOMES

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I have twice encountered two remarkable outbreaks of *Sitophilus granarius* Linn. the granary weevil, in homes in Vancouver; in both cases the telephoned reports were so alarming that I made special trips to investigate and in neither instance could I account for the situation.

In the first case, beetles had been issuing from under the quarter-round on the north and east sides of a first-floor back-bedroom for two days and were still streaming southwards and spilling over into the hall. Across the hall in the living room, beetles were slowly crawling around having apparently issued from under the quarter-round on the south side. Most remarkable of all, was a sheet of beetles some four feet across, in the grass of the lawn on the west side, between the houses. There was no indication where these lawn insects came from; they were slowly crawling around and around in a black carpet-like mass.

I enquired of the people if they had any shelled corn or grain stored in the basement or any forgotten sack of cereal of any kind; they had never had anything of the sort in the two years that they had lived there. I inspected the whole basement with greatest care and found no trace of any possible breeding material. I asked if they had ever kept chickens; they said they had not but the previous owners had kept poultry in the garage at the back of the lot, adjoining the lane, two years ago.

The only explanation I could give for this black horde of weevils was that the previous owners had kept sacks of corn or other grain in the basement as poultry feed, that rats or mice had stolen the feed and stored it somewhere in the walls, that the weevils had infested the feed until it was exhausted and were finally issuing from their breeding place in the huge populations which they had attained in two years time.

In no way could I account for the black mass of weevils in the isolated mass on the lawn; they had not been seen travelling there—they just appeared there.

The second instance occurred in the home of an airman who had been in a rented house for about six months; a steady trickle of granary weevils was issuing from under the quarter-round in the hall upstairs and slowly crawling southwards down the hall; they had been emerging for two days before I inspected the house. Again I examined the basement with greatest care; there was no sign of grain anywhere and the floors and walls were sound and without cracks; moreover there was no place in the garden where anybody could have kept poultry. In this case, I could not even suggest the breeding place of the weevils and recommended the continuous use of the vacuum cleaner for their removal; there was no place to apply insecticides; the wall extended only to the floor below and not to the basement: there was no indication how any material for breeding could have been introduced into the wall from which the beetles were issuing.

## A NOTE ON ENGINE VACUUM FOR ASPIRATING INSECTS[1]

W. H. A. WILDE[2]

Studies on vectors of stone fruit virus diseases often require test insects in large numbers. Usually these are Homoptera such as leafhoppers, psyllids, spittle bugs or aphids. Various methods have been devised (1) for aspirating large numbers of these. In my previous collecting with conventional mouth aspirators, minute particles of sand, plant and animal matter had appeared in the sputum, indicating that there was risk of permanent damage from irritation or myiasis (2). This note describes a well-proved method using part of the vacuum of 18 to 20 inches of mercury, available in most truck and car engines. The method differs in details from that of Moore (3) for collecting grasshoppers.

For vehicles with vacuum-operated windshield wipers, cut the wiper vacuum hose under the dashboard, insert a ⅜ in. brass T-shaped connection into the two cut ends, and attach an aspirator supply hose to the third outlet. The aspirator supply hose should be ' long enough to come through, or up to the level of, the dashboard to which it is attached for easy connection with the aspirator tubing.

For vehicles with electrically-operated wipers, bore a hole in the intake manifold below the carburetor for a source of vacuum. Thread the hole and insert a stop cock with a ⅜ in. hose connection for the vacuum line which is then taken through the fire wall to the interior of the vehicle and attached to the dashboard. This takes about 4 ft. of ⅜ in. windshield wiper hose. By inserting extra T-shaped connections more than one aspirator may be used from the vacuum line.

Window screens of 32/in. mesh should be used. The screens are not absolutely necessary, but the temperature on a hot, sunny day in a closed cab is often fatal to the insects and always uncomfortable for the operator. Connect a conventional straight aspirator (1) to the aspirator tubing. Start the motor and set it to run at medium idling speed. Attach the vacuum gauge to the nozzle of the aspirator and adjust for the required vacuum with a Hoffman clamp on the tubing close to the aspirator. For leafhoppers 2½ to 4 in. of vacuum is required, for spittle bugs 3 to 6 in.

Even where it is not possible to drive a vehicle close to the collecting site, time can still be saved by sweeping with 3 or 4 conventional nets, then returning to the vehicle to aspirate the catch. Release the catch inside

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[2] Entomologist.

the vehicle with the doors closed and aspirate the desired insects from the windshield, doors and screens. When 50 to 100 insects are in the aspirator, transfer them to a collecting jar. This avoids damage from swirling particles in the air stream or from the insects piling up. The transfer is easily made from a straight aspirator into a preserving jar, if the jar lid has a self-closing valve made from a piece of inner tube rubber. Shut off the vacuum by pinching the aspirator tubing, insert the nozzle of the aspirator in the jar and tap the aspirator gently to dislodge the insects. Shutting off the vacuum in this way does not interfere with the vacuum setting.

Leafhoppers collected with this method showed a better rate of survival in vector studies than those taken by conventional methods, probably because it was easy to select undamaged specimens.


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## A COLLECTION OF HYMENOPTERA FROM BRITISH COLUMBIA

By John Stainer

This collection consists of species taken during the summer of 1939, at Okanagan Mission, with a few species collected at Vancouver Island points. I am indebted to Dr. R. Lambert, C. D. Miller, W. R. Mason, and G. S. Walley of the Division of Entomology, Ottawa, for their identifications; and to Prof. G. J. Spencer for his help with this paper. Most of the specimens are now in the National Collection at Ottawa, the remainder in my own collection in Parksville.

Of the 50 species listed 11 are not recorded from B.C. in the "Synoptic Cataloque of the Hymenoptera of America North of Mexico" (U.S. Dept. of Agriculture, April 1951). Some interesting points arise in geographical distribution. Of the Apoidea collected only 1 species has a continent-wide range; the ranges of 6 straddle the Rockies; and 23 are recorded West of the Rockies only. On the other hand of the other superfamilies 14 species have a continent-wide range, 3 more have ranges which straddle the Rockies; and only 3 are restricted to the West side of the Rockies. This follows a pattern evident in the Synoptic Catalogue, shown by these figures:

Per cent of American species with ranges which cross the Rockies

| | |
|---|---|
| Genus *Andrena* | 2.5 |
| Genus *Dasymutilla* | 11.2 |
| Genus *Chrysis* | 34.0 |

In the following list the specimens were taken at Okanagan Mission in 1939, unless otherwise indicated. Months of capture are given in Roman figures.

### TENTHREDINOIDEA

#### Cimbicidae

*Cimbex americana pacifica* Cress. ♂ Parksville; 10. viii. 54.

*Tenthredo varipictus* Nort. ♀ Shawnigan Lake;—V. 54.

### ICHNEUMONOIDEA

#### Ichneumonidae

##### Pimplinae

*Xorides cincticornis* Cress. Nanaimo;—viii. 52.

##### Ichneumoninae

*Cratichneumon unifasciatorius* Say. Parksville;—viii. 53. and 10. ix. 53.

### CHRYSIDOIDEA

#### Chrysididae

*Hedychridium fletcheri* Bod. 24. v. Nearest previously recorded range: Alta., Ida., Ore.

*Chrysis (Chrysura) pacifica* Say. 5. v. and 22. v.

*C. (C.) tota* Aaron. 30. iv. Nearest previously recorded range: Ida., Colo.

*C. (Chrysis) coerulans* Fab. Nanaimo; 12. viii. 56. 23.v.

*C. venusta* Cress. 24. v. Previously recorded range throughout U.S.

*C. (Pyria) fabricii* Mocsary. 20. vi. Nearest previously recorded range: Calif., Ariz.

## SCOLIOIDEA

### Sphaeropthalminae

*Dasymutilla nigripes* Fab. (2) 27. iv. Not previously recorded west of Alta., Ariz.

*D. vesta* Cress. (2) 1.v. and 7.v. No previous record west of Rockies.

## VESPOIDEA

### Eumeninae

*Ancistocerus antilope antilope* Panz. Hornby Island;—viii.52.

*A. catskill albophaleratus* Sauss. (3) 22. v.

*Symmorphus canadensis* Sauss. 7. v.

### Pompilinae

*Anoplius insolens* Banks. (7) 17. iv. to 26. vi.

## SPHECOIDEA

### Pemphredoninae

*Passaloecus mandibularis* Cress. Nanaimo; —. viii. 51.

### Sphecinae

*Podalonia communis* Cress. (15) iv. to v. Ladysmith, V.I.; iv. to v. 39. Range Western U.S.; not recorded from B.C.

*Sceliphron caementarium* Drury. 8. v.

### Nyssoninae

*Bembix (Epibembix) comata* Parker. (4) Cherry Point; 5.viii.42. Hornby Island; —.vii.52. Nanaimo;—.viii.52.

### Philanthinae

*Philanthus flavifrons* Cress. (3) Nanaimo; 10.vi.51. French Creek, V.I.;—.vi.54.

## APOIDEA

### Andrenidae

*Andrena candida* Smith. ♂ ♀ 20.iv. Cherry Point; 4.v.42.

*A. carliniformis* Viereck and Cockerell. ♀♀ 8. and 14.v. Nearest previously recorded range: Calif., Utah, Wyo.

*Andrena* (?) *compactiscopa* Viereck 2♀♀ 14.v.

*A. erecta* Viereck. ♀ Cherry Point; 5.iv.42.

*A.* (?) *perarmata* Cockerell. ♂ 4♀♀ 1. to 16.iv.

*A. prunorum kincaidii* Cockerell 2♀♀ Kelowna; 10.v.39. Nanaimo;—.vii.52.

*A. sladeni* Viereck. 3♂♂ 5♀♀ 10. to 16.iv. to 24.v.

*A. (?) striatifrons* Cockerell. 2 ♀♀; 24. iv. to 24.v.

### Halictidae

*Halictus rubicundus* Christ. 8♀♀ 15. to 16.iv. Cherry Point, 4.v.42.

*H. virgatellus* Cockerell ♀ 23.iv.

### Megachilidae

*Chelynia (Melanostelis) rubi* Cockerell. ♀ 22.v. Nearest recorded range Alta., Wash., Calif., Colo.

*Hoplitis (Monumetha) albifrons argentifrons* Cress. ♀ 6.vi.

*H. (Chlorosmia) fulgida fulgida* Cress. ♀ 6.vi. Nearest recorded range Alaska, Yukon, Alta., Ore.

*Osmia (Osmia) lignaria propinqua* Cress. 13 ♂♂ 5 ♀♀ 4.iv. to 21.vi.

*O. (Chalcosmia) coloradensis* Cress. ♂ 8.v.

*O. (C.) texana* Cress. ♀ Nanaimo;—.vii.52.

*O. (Cephalosmia) marginipennis* Cockerell. ♂ ♀ 30.iv. and 16.vi.

*O. (C.) montana* Cress. ♂ ♀ 30.iv.

*O. (C.) pascoensis* Cockerell. ♀ 30.iv.

*O. (Acanthosmoides)* (?) *enixa* Sandhouse. ♀ 14.v.

*O. (Nothosmia) densa densa* Cress. ♂ 6.vi.

*O. (N.) juxta subpurpurea* Cockerell. ♂ 8.v.

*Megachile (Delomegachile) melanophaea calogaster* Cockerell. ♀ Parksville; 22. vi. 53.

*M. (D.) melanophaea melanophaea* Smith. ♀ Nanaimo; 1.viii.52.

### Apidae

*Anthophora bomboides standfordiana* Cockerell. ♀ 21.vi.

*A. pacifica pacifica* Cress. ♂ 4.v.

*Emphoropsis murihirta* Cockerell. 8♂♂ 9♀♀ 2.iv. to 14.v. Nearest recorded range Calif.

*Melecta pacifica* Cress. 2♂♂ 16.iv.

*Ceratina acantha submaritima* Cockerell. ♀ 19.v.

*Bombus mixtus* Cress. ☿ Nanaimo, 5.viii.51.

## A Note on the Oviposition of NYCTOBIA LIMITARIA Wlk.

On May 4, 1950, about 3:30 p.m., I noticed a female of the geometrid **Nyctobia limitaria** Wlk. flying in a leisurely way amongst the coniferous undergrowth bordering the creek at the Trinity Valley Forest Biology Field Station. I watched for about ten minutes before it flew down a steep bank and was lost; while under observation it settled about ten times on young Douglas fir, Engelmann spruce, and western red cedar. By following the moth I was able to pick out six eggs which it laid on the spruce and fir foliage. It showed no preference for either host, but was attracted to trees growing close to the water; twice it returned and laid a second egg on a tree of each species almost overhanging the creek. When ovipositing, the moth rested motionless, the wings half extended, on the upper side of a spray of foliage; the abdomen was curved downward and forward and the eggs were laid on the under side of the needles. On at least one occasion when the moth perched on a cedar, its proboscis was extended and it appeared to be taking moisture from the surface of the foliage.

At the time these observations were made the sun was shining and the temperature at the nearby field station was about 58° F. In the vicinity of the creek the temperature was judged to be at least ten degrees colder and most of the understory was in shade.

—*J. Grant, Forest Biology Laboratory, Vernon, B.C.*

# A PORTABLE TENT-CAGE FOR ENTOMOLOGICAL FIELD STUDIES[1]

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The requirements for cages in entomological field work vary widely in accordance with the insect and host material under study. This paper describes the construction, advantages, and disadvantages of a lightweight, portable tent-cage developed during recent investigations of the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk. It was designed to facilitate the study of the bark beetle and associated insects with known populations in logs under field conditions.

The tent cages shown in the accompanying illustrations are six feet long with sides and floor four feet wide, thus forming in cross section, an equilateral triangle with a height of approximately three and one half feet. The floor is of 10-ounce canvas with four corner loops of the same material and a plastic-screen drain to prevent the accumulation of water. The walls are of 22-mesh netting with ¼ inch rope running beneath cotton tape along the apex and extending as ties beyond each end. Nylon netting was found to be more durable than cotton mesh and has less tendency to stretch when damp. However, it deteriorates upon long exposure to sunlight, but this condition is seldom encountered in the shade of the forest.

A simple sleeve formed by three-foot extensions of the nylon mesh from the walls and floor, closed by gathering and tieing with cord proved satisfactory as a door (Fig. 1). This system worked better than a design in which flaps from the walls and floor were rolled on dowels to effect closure (Fig. 2). Further improvement might be made in the method of closing by employing inexpensive plastic zippers to fasten the free sides of a flap-type door.

The cages are set up by staking the tarpaulin floor with pegs through the loops to a level area of ground between two trees and fastening the ties, adding light rope if necessary, to the trees at or above breast height, depending on the distance between the trees. Two pieces of 2" x 4" lumber placed under the tarpaulin floor prevent the contents of the cage from pressing the canvas to the ground where it may rot. Short rollers about three inches in diameter help to ease the logs into the cages. The rollers, supported by the 2" x 4" wood beneath the floor, are then blocked in place with wooden wedges, holding the log off the floor and permitting complete air circulation around it.

These tent cages have one disadvantage when used in the Cariboo region of British Columbia. Rabbits and mice cause considerable damage to the material gathered together where the cages are closed. However, small tears can be repaired easily with patches of muslin applied on both sides of the netting with a rubber base cement between.

These cages have been used successfully for three years of Douglas-fir beetle brood and population studies. Although they could not be used during winter where snow may damage them, they have a number of advantages. Since they weigh only four pounds and can be folded tightly (12" x 14" x 3"), several can be carried by one man into areas inaccessible by road. The accessories, such as pegs, rollers and floor supports, can be made readily from material available in the forest. Two men can erect a cage in five minutes. A cage will accommodate a log five feet long and eighteen inches in diameter with sufficient room available for one to enter and examine the experimental material (Fig. 3). Manufactured cost per unit is about sixteen dollars on the West Coast.

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[1] Contribution No. 568, Forest Biology Division, Research Branch, Department of Agriculture, Ottawa, Canada.

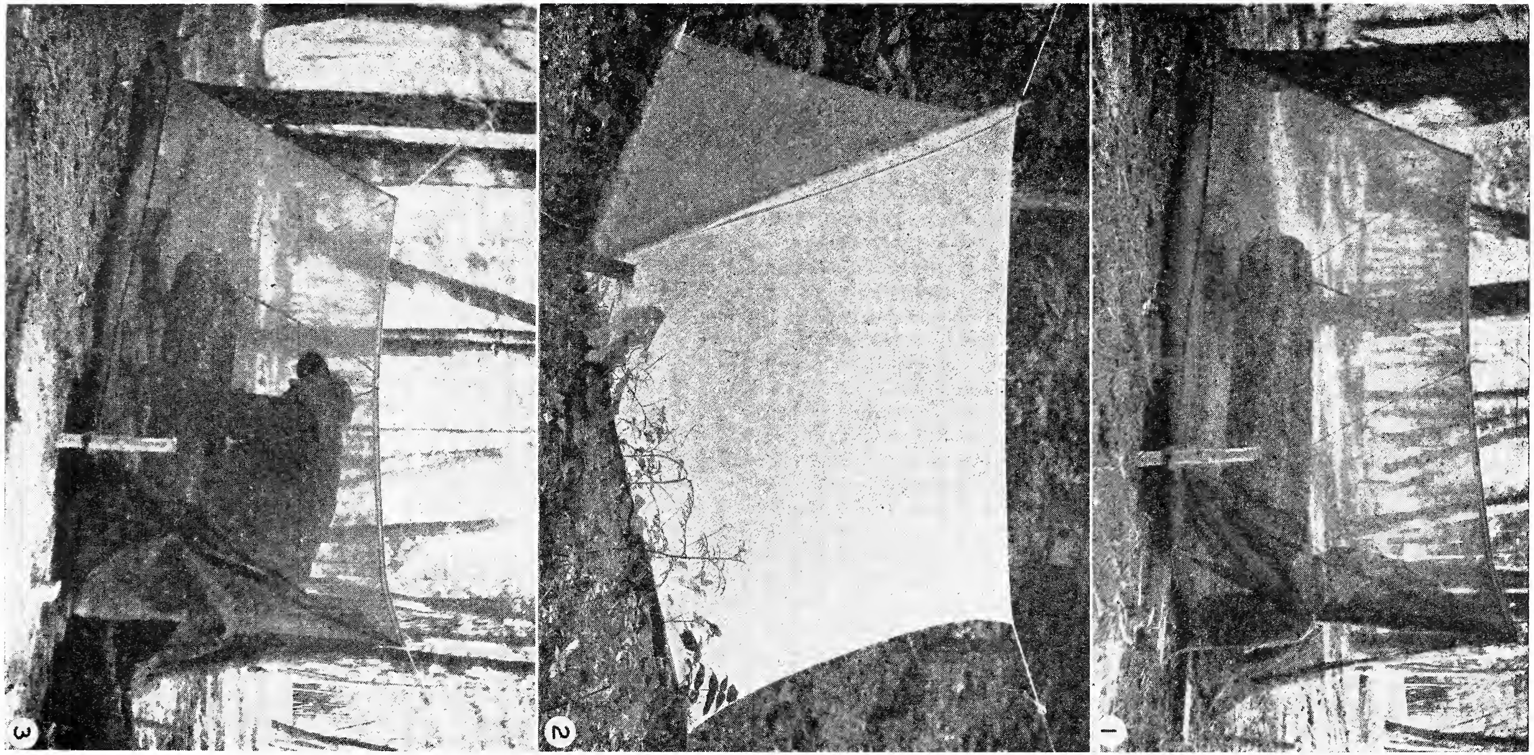

**Fig. 1.** Nylon-mesh tent-cage showing continuous apex ties and front opening closed by gathering of 3-foot sleeve tied with cord.

**Fig. 2.** Cotton-mesh tent-cage showing front opening closed by rolling flaps on dowels.

**Fig. 3.** Nylon-mesh tent-cage showing ease with which contents can be examined.

# AN UNUSUAL MANIFESTATION IN THE NATURAL CONTROL OF THE PEAR PSYLLA, *Psylla pyricola* FOERST[1]

J. MARSHALL[2]

Although it appeared in British Columbia over sixteen years ago[3], the pear psylla, *Psylla pyricola* Foerst., was not, generally speaking, a very serious pest until 1958. Natural control has been, in the main, reasonably adequate. But since we have done no work on the biology of the insect in British Columbia, natural control, in all its forms, has been a matter for speculation. We had, however, formed an impression that the semi-arid Okanagan Valley is not as favourable for the development of the insect as, for example, more humid New York State where the pear psylla has long been a serious pest[4].

In the Okanagan Valley, and in the neighbouring Similkameen Valley, the summer of 1958, long, hot and dry, was in marked contrast with the mid-continent type of summer under which the pear psylla thrives. Just before the hot weather began we undertook an orchard experiment on the chemical control of the pear psylla in the Similkameen Valley and, incidental to the experiment, compiled infestation records on non-sprayed check trees before and after several days of hot weather. The records are given in Table 1. We repeated the experiment in a second pear orchard at Penticton in the South Okanagan and the corresponding records are given in Table 2.

TABLE 1—**Similkameen Orchard.** Number of pear psyllids, 20 leaves per tree, on check plot before and after hot weather (96° - 98°F.)

| Tree | May 15 Living | May 15 Dead | May 26 Living | May 26 Dead |
|---|---|---|---|---|
| 1 | 21 | 0 | 0 | 6 |
| 2 | 14 | 6 | 0 | 6 |
| 3 | 18 | 5 | 0 | 11 |
| 4 | 38 | 5 | 0 | 29 |
| 5 | 22 | 6 | 0 | 10 |
| Total | 113 | 22 | 0 | 62 |

Unseasonably hot weather occurred May 24 to May 27 when the maximum temperatures at the Entomology Laboratory were 87° to 88° F. Since the laboratory is situated on the shore of Okanagan Lake, which has a moderating effect on the temperature, the maxima in the Similkameen orchard are estimated to have been about 96° to 98° F. and, in the Penticton orchard, perhaps 92° to 94° F. Temperature maxima for the previous two weeks were 5 to 10 degrees lower. During the hot period the relative humidity was frequently below 30 per cent.

Both tables show that the pear psylla suffered heavy mortality between the time of the first and second observations, i.e., during the period of hot, dry weather. The only predator that appeared to be attacking the psyllids was the anthocorid bug, *Anthocoris antevolens* White; but it was so rare that it is doubtful if, in the course of a few days, it could have had much effect on the numbers of psyllids. In all likelihood, then, the chief lethal factor was the weather.

In the first to third instars the delicate pear psylla nymph excretes copiously a water - white, syrupy honey-dew beneath the protective covering of which it feeds. The more strongly sclerotized four and fifth

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[2] Entomologist.

[3] Marshall, J., and H. F. Olds. The pear psylla in British Columbia. Proc. Ent. Soc. British Columbia 43:1-3. 1947.

[4] Slingerland, M. V. The pear tree psylla. Cornell Univ. Agr. Exp. Sta. Bull. 44:151-186. 1892.

TABLE 2—**Penticton Orchard.** Number of pear psyllids, 20 leaves per tree, on check plot before and after hot weather (92° - 84°F.)

| | May 23 | | May 27 | |
|---|---|---|---|---|
| Tree | Living | Dead | Living | Dead |
| 1 | 39 | 9 | 8 | 32 |
| 2 | 36 | 6 | 18 | 96 |
| 3 | 29 | 9 | 15 | 49 |
| 4 | 20 | 4 | 19 | 13 |
| Total | 124 | 28 | 60 | 190 |

instar nymphs move about freely without such protection.

Following the hot weather we noticed that many of the dead, fourth and fifth instar nymphs appeared somewhat desiccated. Although the evidence was circumstantial, presumably they had been killed by excessive evaporation. Not so the fate of the first to third instar nymphs; the manner of their demise was as obvious as it was curious. Their protective gobbet of honey-dew had solidified to the consistency and appearance of pasteurized white honey, and immovable in their transformed excretion, they had become victims of their own metabolic processes. (See Figures 1 and 2.) Bonnemaison and Missonnier[5] working with the very closely related *Psylla pyri* in France report that hot, dry weather is particularly injurious to the early instars of that species but they do not mention crystallization of honey-dew as a contributory condition.

Despite the hot, dry weather in 1958, many growers were convinced that, as in several previous seasons, pear psylla infestation was serious enough to necessitate spraying once or oftener with an organic phosphate, i.e., malathion, Diazinon or parathion. So it is odd that, although there was apparently as heavy a winter carry-over of psyllids in the non-sprayed Entomology Laboratory orchard as in the commercial ones and even although temperatures in that orchard were somewhat lower than in many others, it suffered no psyllid damage. I suspect that commercial spray practice, particularly where it involves the application of organic phosphates, may in the long run encourage, rather than discourage, psyllid infestation. But if the natural control of the pear psylla in the Okanagan and Similkameen valleys is largely the outcome of unfavourable weather rather than of biological control, why should the application of any anti-psyllid chemical eventually favour the insect? It is unlikely that the question will be answered until the life-history and ecology of the pear psylla are studied under arid or semi-arid conditions.

[5] Bonnemaison, L., and J. Missonnier. Le psylle du poirier (**psylla pyri** L.) Morphologie et biologie. Methodes de lutte. Ann Epiphyties 2:263-331. 1956.

## Summary

1. In the semi-arid Okanagan Valley the pear psylla has not, as a rule, been as serious a pest as in more humid pear-growing areas.

2. Hot, dry weather proved injurious to the pear psylla. The freely moving fourth the fifth instar nymphs presumably were killed by desiccation; the first, second and third instar nymphs were killed by the solidification of the gobbet of honey-dew within the protection of which they feed.

3. Biological control agencies apparently are not so important in suppressing the insect as the weather.

## Acknowledgment

R. S. Downing and Kenneth Taylor assisted in taking records. The photographs are by S. R. Cannings.


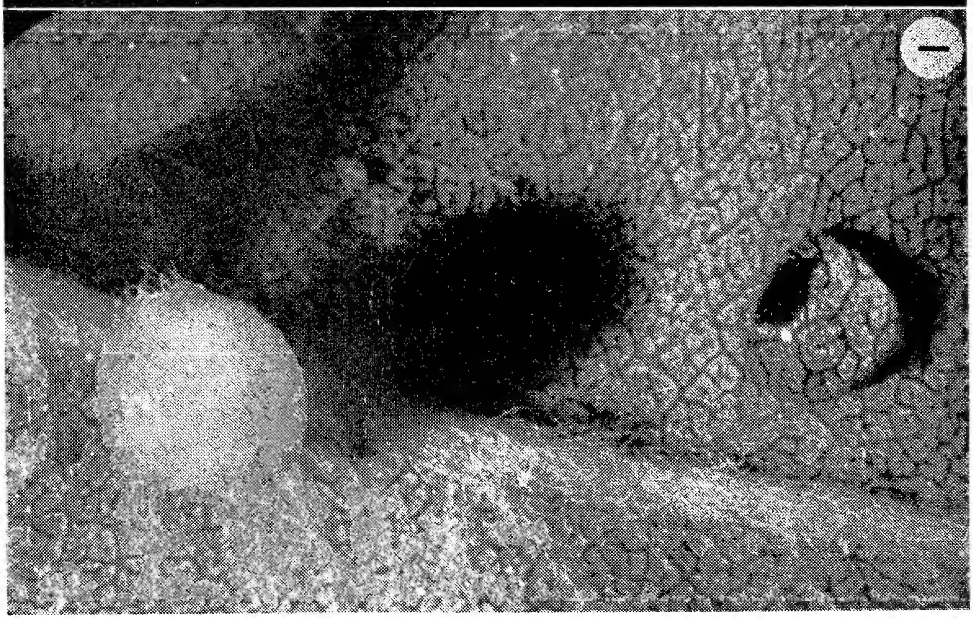


Fig. 1.—Solidified honey-dew (above) and live pear psylla nymph in liquid honey-dew (below).

Fig. 2.—Pear psyllids embalmed in their own crystallized honey-dew.

# THREE INSECTS NEW TO VANCOUVER

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On July 10, 1958, Mrs. J. A. Shiers of 4816 Angus Drive, Vancouver, brought in several twigs and small branches of Copper beech on which all the leaves were heavily infested with blotch mines. The branches were caged and for the next two weeks produced tiny moths of the family Gracillariidae, genus *Lithocolletis,* but a far greater number of hymenopterous parasites of three species. The parasitism ran about 90 percent. Mrs. Shiers said that the beeches were 40 to 50 feet high and that a few mines had been noticed in the topmost leaves in 1957, but that in 1958 the whole appearance of the tree was spoiled; other trees in her neighborhood were not infested. This is the first time I have encountered this trouble and I can find no record of it on this continent or in England. The moths and their parasites have not been identified as yet.

The second unusual record came from a hardwood importing firm whose shipment of 1"x6" Tennessee cedar boards was producing hordes of beetles. These were half-inch long, longicorns of a beautiful bluish purple colour which Dr. Gorton Linsley identified as *Callidium schotti* Schaef. I am grateful to Mr. H. B. Leech of the California Academy of Sciences for getting these beetles identified for me. I kept them in a cage and for the next three weeks they rushed about furiously in jerks over the boards, spending much time mating. Eventually the females laid many eggs on the small portions of bark adhering to sides of the boards. When the eggs hatched the minute larvae moved into the bark and soon disappeared. However, none succeeded in becoming established, so it is unlikely that this insect will breed in our climate on local cedars. An entomologist from West Virginia told me that this beetle is specific to Tennessee or Eastern cedar.

The third record concerns a terrific infestation of Phylloxera in July and August 1958 on a four-foot English oak in my back yard, so extensive that every leaf was heavily infested. The insects caused pale blotches above where they were feeding so that the general effect was that of a fungous disease. The oak is six years old and has never shown this damage before. The Phylloxera cannot be keyed out amongst the 11 species that Duncan described from oaks in California so it may be either recently introduced into this Province or new to science.

The insect was in two forms, winged and wingless. The latter was shaped like a peg top, was larger in body than the winged ones and laid reddish brown oval eggs in semi- or in full circles. It rotated on its front legs, laying eggs like radii of a circle.

Its development is unknown, for the tree was so thoroughly sprayed three times that it is not likely that the Phylloxera survived.

Oaks less than 70 yards away on the boulevard had no similar infestation, so the origin of the insect is a mystery.

## Reference

Duncan, Carl D. 1922. The North American species of Phylloxera infesting oak and chestnut. (Hemiptera, Phylloxeridae) Can. Ent. LIV. No. 12.

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